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A Record of the Progress of Pharmacy and the Allied Sciences

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PHARMACEUTICAL PRODUCTS

THE AMERICAN
JOURNAL OF PHARMACY

VOL. 95. MAY, 1923. NO. 5.

EDITORIAL

"THERE ARE STILL EYE-WITNESSES OF THIS CASE IN BRUSSELS."

From a recent issue of a big city newspaper we quote the following dramatic recital of the wonderful invention of a medical wizard of the West:

"By the aid of this marvelous instrument the oscilloclast, Dr. A., its inventor, is able to determine with unfailing precision the nature of a person's ailments simply by the examination of a drop of the patient's blood. This examination may be performed with the patient a thousand miles away.

"According to Dr. A., blood, even in the dried condition, possesses certain electronic vibratory rates which are constant in health but which vary in a characteristic way for every known disease. These variations may be recorded by the oscilloclast, and a true diagnosis established in this simple (sic!) manner. Treatment is then instituted by utilizing an electronic appurtenance to rotate the blood vibrations back to normal rate.

"Dr. A. has been unfortunately handicapped by the ridicule and opposition of organized medicine, opposition probably engendered by the knowledge that Dr. A's discoveries are bound eventually to revolutionize the practice of medicine and surgery. Upton Sinclair, the famous author, has recently investigated the work of Dr. A., and has returned a report highly complimentary to the efforts of this modest medical inventor, and completely vindicating him of the asseverations made by the National Medical bodies, who accuse him of being an unscientific blundering charlatan."

Information now comes to us that disciples of this wonder man of the West are scattered the country over to practice the teachings and utilize the diagnostic invention of their master—and they are finding a ready market for their unscrupulous wares. Very frequently these men are practicing medicine in some form or another and so have no difficulty in finding a clientele. The other day, how-

ever, a doubting doctor bearing the fitting name of Thomas, lanced a healthy young pig, collected a few drops of its blood, and sent it off (labeled Mr. Hogg, and enclosing the very necessary fee) to a disciple of A's for a "diagnosis." Back came a report to the effect that Mr. Hogg's blood showed vibratory rates corresponding to an "incipient locomotor ataxia" (which may account for the restlessness of a brand of sausage with which we were recently served). And to think that such quacks and cheaters can find persons foolish enough, either from ignorant sincerity or else sincere ignorance, to believe in their blatant and idiotic practices.

Truly the current generation is no less gullible than the generation that existed in the golden age of dogmas and delusions, when moss from a dead man's skull collected at the rising of the moon during the early months of autumn, was considered panacea for all mortal ills.

Witness another quotation from a volume,* which records the chronicles of the pharmacy of long ago, and thus describes a condition that formerly obtained in medical circles, and which bears interesting comparision with the hectic beliefs and teachings of this modern school of oscilloclastics and vibratorians.

"Robert Fludd, M. D., the Rosicrucian, who fell under the displeasure of the College of Physicians on account of his unsound views from a Galenical standpoint, was a warm advocate of the Paracelsian Weapon Salve. In reply to a contemporary doctor who had ridiculed the theory he waxes earnest, and at times sarcastic. He explains that 'an ointment composed of the moss of human bones, mummy (which is the human body combined with balm), human fat, and added to these the blood which is the beginning and food of them all, must have a spiritual power, for with the blood the bright soul doth abide and operateth after a hidden manner. Then as there is a spiritual line protracted or extended in the ayre between the wounded person and the Box of Ointment like the beam of the sun from the sun, so this animal beam is the faithful conductor of the healing nature from the box of the balsam to the wounded body. And if it were not for that line which conveys the wholesome and salutiferous spirit, the value of the ointment would evaporate or sluice out this way or that way and so would bring no benefit to the wounded persons.'

**Wooton's Chronicles of Pharmacy.*

"Van Helmont, Descartes, Batista Porta, and other leaders of science in the seventeenth century, espoused the theory cordially enough. Van Helmont's contribution to the evidence on which it was founded is hard to beat. In his 'De Magnetica Vulrernum Curatione,' written about 1644, he relates that a citizen of Brussels, having lost his nose in a combat in Italy, repaired to a surgeon of Bologna named Tagliacozzi, who provided him with another, taking the required strip of flesh from the arm of a servant. This answered admirably, and the Brussels man returned hime. But thirteen months later he found his nose was getting cold; and then it began to putrefy. The explanation, of course, was that the servant from whom the flesh had been borrowed had died. Van Helmont adds, 'Superstites sunt horum testes oculati Bruxellæ' (*'there are still eye-witnesses of this case at Brussels'*)."

It may require quackeries more subtle than the foregoing to influence the generation that lives today, but we are still far-off from that community education which enables distinction to be made between true medical service and the false and dishonest practices indulged in by charlatans in and out of the statutory ranks of medicine.

"There are still eye-witnesses in Brussels," in our land also, who either from rank ignorance or because of a tolerant idiosyncrasy for coin of the realm, will attest to the merit of any quackery, no matter how false and absurd it may be.

I. G.

SELECTED EDITORIAL

THE NEED FOR A MORE THOROUGH ORGANIZATION OF AMERICAN PHARMACY.

While there were a few local and even state associations of pharmacists in this country prior to 1851 when the American Pharmaceutical Association was founded, yet that year marks the real beginning of pharmaceutical organization in the United States. The impetus given by the American Pharmaceutical Association resulted in the development of the state pharmaceutical associations, who are in this sense, children of the A. Ph. A., and the same spirit later gave rise to the several national organizations who are so well serv-

ing the various interests of pharmacy. But while this development of associations representing the different groups was most necessary, yet the need for co-ordinating them into a closer federation was increasingly apparent. In the effort to bring about such a federation, there is no thought of antagonizing, much less of replacing, any existing organization but rather of increasing their efficiency through a closer union. With the national organizations, an excellent start has been made in the Drug Trade Conference—which has already accomplished so much for pharmacy. But to unite especially the state associations and to bring them into a closer touch with the parent body is an immediate and urgent need.

Those who had the privilege and opportunity to look in upon some three hundred of the leaders of American pharmacy as they sat considering this question at the Cleveland meeting of the A. Ph. A. held last August realize that the whole problem of pharmaceutical organization is being given more serious thought than ever before. There sat delegates representing every possible phase of pharmaceutic activity. Crude-drug importers and producers, manufacturers, wholesalers, retail pharmacists, commercial and professional men, pharmaceutical journalists, everybody, every interest was represented.

These men, realizing that positive action looking toward the building up of a great federation of pharmaceutical associations was necessary did something which never before has been done in the history of American pharmacy. They adopted and directed to be placed before the pharmacists of America a plan for a comprehensive and yet effective organization. They now ask that the great body of American pharmacists as represented by the state pharmaceutical associations approve the plans for organization as outlined.

The plans are the result of continued and serious study by a group of our most able men. They are not held to be perfect. No plan ever is. They represent the best that can be produced preliminary to actual use. The pharmaceutic world is now waiting for the druggists of the country through their respective state associations to speak; awaiting for the druggists of the United States to say "Yes—we approve the plans and urge that no effort be spared or time lost in bringing about the proper adjustment of

by-laws, etc., so that the actual work of organizing may be started; so that the serious problems which are becoming an increasing menace to the very life of pharmacy may be adequately and equitably solved in the interest of the entire pharmaceutic body and the public."

This appeal for approval comes not from a small group representing a certain phase of the pharmaceutical activity of the country, but rather from a united group representing *every* branch of pharmacy. It is backed by officers and delegates from practically every drug organization in the country. All were present at the Cleveland conference. The officers and executive committeemen of the N. A. R. D. and A. Ph. A., representatives of all branches of the manufacturing industry relating to drugs and allied products, delegates from state associations, boards of pharmacy, wholesalers, scientists, government officials and others.

Now comes the official request through the officers of the American Pharmaceutical Association that the rank and file of pharmacists of the country through their state associations approve the plans. This is as it should be. The A. Ph. A. is the only existing organization to which *all* having any interest in the drug business are eligible for membership. The retail pharmacists of the country, some 50,000 of them, represent the largest single group having a vital interest in drugs.

It is to be hoped that these state associations as they meet one after another during the coming six months will approve these plans for a real national federation of pharmacy with votes that can be heard from coast to coast and from Canada to the Gulf of Mexico.

The opportunity is now here and every pharmacist should attend his state meeting with the one thought uppermost in his mind of putting his state solidly back of the big task to be accomplished. No funds are required or asked to be pledged. The one question is, are you ready to ORGANIZE? We have yet to find a pharmacist who is a "Doubting Thomas."

When your state association officers present this subject put it across with a bang, and let's help American Pharmacy on the road to recognition and prosperity.

ORIGINAL ARTICLES

CATALYSIS AND CATALYSTS.

By Samuel P. Sadtler, Ph. M., Ph. D.

(Emeritus Professor of Chemistry, Philadelphia College of Pharmacy and Science.)

[One of a Series of Popular Lectures Delivered at the Philadelphia College of Pharmacy and Science.]

A number of isolated observations, in which the presence of an activating substance, not figuring apparently in the reaction when expressed in its simplest terms, had been recorded in the early part of the nineteenth century. Thus the conversion of starch to sugar by means of dilute acids had been recorded by Kirchhof in 1812; the action of finely divided platinum to oxidize ethyl alcohol to acetic acid was demonstrated by Edmond Davy in 1820; Döbereiner's use of spongy platinum to inflame a jet of hydrogen gas in the presence of oxygen or air noted in 1822; and lastly the part played by sulphuric acid in the conversion of alcohol into ether noted by Mitscherlich in 1834, were all on record when Berzelius in a communication in 1835 called attention to certain features distinguishing these reactions. He says: "It is then proved that several simple and compound bodies, soluble and insoluble, have the property of exercising on other bodies an action very different from chemical affinity. By means of this action they produce, in these bodies, decompositions of their elements and different recombinations of these same elements to which they themselves remain indifferent.

"This new force, which was hitherto unknown, is common to organic and inorganic nature. I do not believe that it is a force quite independent of the electro-chemical affinities of matter; I believe, on the contrary, that it is only a new manifestation of the same; but, since we cannot see their connection and mutual dependence, it will be more convenient to designate the force by a separate name. I will, therefore, call this force the *catalytic force,* and I will call *catalysis* the decomposition of bodies by this force in the same way that one calls by the name *analysis* the decomposition of bodies by chemical affinity."

Clearly Berzelius, while making a distinction in name, was un-

able to indicate the nature of the difference in the several reactions.

Nor was the matter improved by Liebig, who discussed catalytic reactions shortly after this. The introduction of the idea of "chemical reaction velocity," as the key to the meaning of catalytic reactions, first by Wilhelmy and later elaborated by Ostwald, was the important step in advance. Ostwald therefore defines a catalyst as follows: "Catalysts are substances which change the velocity of a given chemical reaction without modification of the energy factors of the reaction." Later writers have widened this view of Ostwald by insisting that a catalyst may actually initiate a reaction. So the broadest definition is that given by Sabatier, one of the most fruitful workers in this field. He says: "By catalysis we designate the mechanism by virtue of which certain chemical reactions are caused or accelerated by substances which do not appear to take any part in the reactions." It must be noted about this definition, however, that, while the catalyst does not figure in the reaction which sums up the ultimate change effect, we learn nothing from it as to how the catalyst acts on the substances with which it is brought in contact.

"The theories which have been advanced to explain the mechanism of catalysis fall into two classes, the chemical and the physical. The former asserts that the effect of the catalyst is to be attributed to the continuous formation and decomposition of unstable intermediate products; whilst the physical theory explains the phenomena as being due to the condensation, or increase in concentration, of the reacting substances at the surface of the catalyst, such increase in concentration being brought about by capillary forces."

Many of our commonest reactions like the well-known liberation of oxygen from a mixture of potassium chlorate and manganese dioxide and its liberation from bleaching powder in the presence of a cobalt catalyst, undoubtedly depend on the formation of unstable intermediate compounds. Indeed the effect of finely divided metals as catalysts may also depend upon the temporary formation of metallic hydrides easily decomposable. So the chemical theory seems to have an excellent basis, but there are also cases where so far no intermediate compound can be figured and the physical theory seems the best explanation. For convenience, two general divisions have been made in the discussion of catalytic reactions; catalysis in homogeneous systems and catalysis in heterogeneous systems.

The first class, that in homogeneous systems includes cases where the catalyst is dissolved in or intimately mixed with at least one of the reacting constituents. All cases of soluble ferments figure therefore as illustrations of homogeneous catalytic reactions. The action of dilute acids as in the inversion of starch or sugar is similarly an illustration. The action of water vapor in inducing reaction of certain gaseous mixtures is also an illustration.

There are many cases of chlorination, oxidation or reduction, where intermediate chemical compounds are indicated as formed, which belong to this class.

The second class, that in heterogeneous systems, covers the cases where a solid catalyst preferably in finely divided condition is brought into contact with gaseous or liquid systems or mixtures. This includes many of the great industrial processes like the contact sulphuric acid process and the hardening of oils or fats by hydrogenation in the presence of finely divided nickel.

Before proceeding with the special mention of catalytic reactions illustrating this classification, we will note some special conditions applying at times to many cases of catalysis.

AUTO-CATALYSIS is a term used by Ostwald to characterize those cases in which the product of the reactions accelerates the reactions. Thus pure nitric acid acts only slowly on many pure metals, silver, copper, bismuth, cadmium and mercury, but when once it is started, the reaction accelerates itself because nitrous fumes are produced which facilitate the attack so that the reaction may become violent.

Similarly, water produced in the reaction frequently greatly accelerates the catalytic reaction of gaseous mixtures. Again, in the hydrolysis of esters by water in the presence of acids, the hydrolysis once started yields the acid which greatly accelerates the reaction.

ACTIVATORS. In many catalytic reactions it has been found that the addition of small quantities of "promoters" or "activators," as they are called, has the result of increasing the activity of catalysts in a very remarkable manner. This appears to be specially the case where the catalyst is a metal, and then the promoters may be other metals, or oxides, hydroxides, or salts of the alkali metals, of

the alkaline-earth metals, and generally of those metals which yield oxides and salts which are not reducible by hydrogen; various other instances of the advantageous employment of promoters are given in the description of the synthesis of ammonia, of the oxidation of ammonia to nitric acid, and of other catalytic processes. The mode of action of promoters is not understood; indeed, our knowledge of the phenomenon is at present limited to some isolated facts, but there can be no doubt that further experimental investigations will lead to a more extended application of this method of activating catalysts.

NEGATIVE CATALYSERS (including stabilizers and catalyser poisons). There are on record many cases in which the addition of certain substances has an inhibiting effect on the progress of the reaction. We would note first the case in which the change is simply retarded. Substances having such effect are known as *stabilizers*. Thus the presence of a trace of sulphuric or hydrochloric acid with hydrogen peroxide retards very greatly the rapidity with which it decomposes; the addition of a small amount of alcohol inhibits the decomposition which chloroform undergoes in the presence of light and air; hydrocyanic acid is stabilized by traces of hydrochloric or sulphuric acid. To the pharmacist, the importance of stabilizers in some of the U. S. P. preparatons is so well known that a mere mention is sufficient. Much more active as inhibiting or neutralizing agents are what are known as *catalyst poisons*. Traces of these substances will completely stop the action of the most active catalysts, which therefore in practice have to be guarded against their contaminating influence, which in common language poisons or renders completely valueless an otherwise active and valuable catalytic agent.

"It is frequently observed that catalytic agents lose their efficiency after being in use for some time, and as a rule this is due to the presence of substances which have an injurious influence. In the contact process for the manufacture of sulphuric acid even traces of arsenic compounds in the gases soon render the platinum catalyst quite inactive; in the synthesis of ammonia from its elements, iron containing as little as 0.01 per cent. of sulphur is of very little use as a catalyst; when using finely divided nickel as a catalytic agent Sabatier found that traces of bromine in the air of the laboratory rendered it impossible to hydrogenate phenol which

had stood there overnight in an open flask, and that benzene which had not been scrupulously freed from thiophen could not be converted into cyclohexane."

. . . . . .

"It will be observed that even minute traces of poisons may have disastrous effects, and therefore, for certain classes of reactions, it is essential to provide for the preparation of contact masses free from poisons or for the removal of such poisons from them, and also for the careful purification of the reacting substances."

Velocity of Catalysis Reactions. As the most distinctive feature of the action of a catalyst is the acceleration of a reaction under its influence, the question of velocity and how influenced becomes important, and there are three of these influences to specially note. Temperature plays an important role. Many catalytic reactions do not take place except above a certain temperature and it greatly increases the velocity of the reactions once started. In many cases there is an optimum temperature ranging within relatively narrow limits, and above this range the nature of the reaction (especially with organic compounds) may change radically or it may cease to be effective. Increase of pressure, the second influence, is only of importance in gaseous systems or in systems having a gaseous phase. For instance, the hydrogenation of liquid fats by gaseous hydrogen is in many cases facilitated by the use of pressure. On the other hand, the decomposition of some organic compounds such as alcohols in the presence of hydrogen is facilitated by reducing the pressure. The quantity of the catalysts is a third influencing element.

"In homogeneous systems, in which the catalyst remains in intimate mixture with the components of the reaction, it acts by its mass and its action increases with its concentration.

"In the manufacture of sulphuric acid by the lead chamber process, in which oxides of nitrogen serve as the catalyst, the velocity is proportional to their concentration up to a certain limit.

"In the inversion of sugar solutions by mineral acids and in the saponification of esters by the same agents, the active agents in the catalysis are the free hydrogen ions arising from the electrolytic dissociation of the acids and the velocity of the reaction is proportional to the concentration of these ions.

"In the catalytic decomposition of hydrogen peroxide by small amounts of alkali, the rapidity of the decomposition is nearly proportional to the concentration of these ions."

In heterogeneous systems, the catalyst may be for instance a solid immersed in a liquid or gaseous medium and exerts its useful purpose only on its surface. Hence, the action depends largely upon the extent of the surface. The state of division of a solid catalyst is a matter of prime importance. With a solid in a fine powder which is readily penetrated by the gas, the useful surface is extremely large as compared with the exterior surface of the layer. Some metals, like nickel in sheets or tin foil, have practically no catalytic power, but in finely divided nickel, it is highly developed and of the greatest importance.

The number of substances capable of acting as catalysts is already very large and continues to increase with the fuller study of various chemical reactions. We find this catalytic action developed by the most varied materials; elements, oxides, mineral acids, bases, metallic chlorides, bromides, iodides, fluorides and oxygen salts, ammonia and its derivatives, and various organic compounds. Some distinguishing differences may be noted. Non-metallic elements are generally effective because of the way in which they can form unstable intermediate compounds which themselves act as facilitating catalytic change. On the other hand, the metals preferably act by surface action, either as finely-divided solids or when in so-called colloidal solution. These latter are at times extraordinarily active as catalysts but require the presence of protective colloids in solution with them to enable them to hold their activity.

Among organic compounds, we have an interesting class occurring in vegetable or animal life products known as *Enzymes*. These are catalysts produced by living organisms, and in all probability are substances of definite chemical composition. In many respects their action resembles that of inorganic catalysts, and especially of such metals as platinum when in the colloidal state. They are specific in their action; that is to say, a certain definite enzyme is required to bring about a particular transformation.

As in the case of inorganic catalysts, a very small quantity of an enzyme will transform a relatively large amount of the substance undergoing change, and in general the velocity of the reaction is pro-

portional to the quantity of the catalyst present, whilst the final result is independent of that quantity. Enzymes, also, like many inorganic catalysts, are very sensitive to the action of "poisons," such as hydrocyanic acid, sulphuretted hydrogen, mercuric chloride, etc.; moreover, in many cases their activity is enhanced by the presence of small quantities of promoters. For instance, the efficiency of lipase in hydrolysing fats is increased by the addition of a trace of manganous sulphate, and trypsin, which is practically inert in acid or neutral solution, is greatly assisted in its action by the presence of alkalis. Auto-catalysis, positive or negative, plays a considerable part in the changes of activity of an enzyme during the course of its action.

"There are, however, certain differences between enzymes and inorganic catalysts, some of which undoubtedly arise from the character of the former as organic colloids. Enzymes are sensitive to heat. In catalysis with these substances, rise of temperature up to a certain point increases the rate of change, and for each enzyme there is a particular optimum temperature, frequently in the neighborhood of 40°, at which its activity is a maximum. At higher temperatures, from 60° to 100°, they are as a rule gradually destroyed, but some under certain conditions are able to withstand the temperature of boiling water. Moreover, although enzymes resemble ordinary catalytic agents in being active in very small concentrations, they lose their activity when a certain amount of the substance on which they act has been transformed; this amount may be large, but is not, as in the case of inorganic catalysts, practically without limit. In many cases the enzyme itself disappears in the course of the reaction."

Solvents. If we take the broad definition of a catalyst either as stated by Sabatier already quoted or the very similar one of Ostwald, we must include solvents as figuring in many reactions as catalysts. Thus dry chemical substances can be mixed intimately in powdered form without any chemical change resulting, but the addition of water which establishes perfect contact between the two substances immediately starts the reaction. The water may be recovered completely unchanged by the reaction. It has acted only as a catalyst. Other solvents may act in a similar way. Solvents are not commonly classed with true catalysts however, as the term

is usually reserved for such substances as act in small concentration and yet are able to cause large quantities of other substances to react.

We will now briefly note some of the most important industrial applications of catalytic reactions which will give an idea of the scope of this method of chemical change.

Inorganic Catalytic Reactions and Processes.

The "chamber process" for the manufacture of sulphuric acid is one of the oldest of our great technical processes. It depends upon the oxidation of sulphurous acid or sulphur dioxide with atmospheric oxygen through the catalytic agency of oxides of nitrogen. It is true that the exact reactions involved in the several stages of this process are not so clear that general agreement upon them has been reached, but that the oxides of nitrogen serve as oxygen carriers is clearly recognized. The absorption of these oxides of nitrogen in the Gay Lussac tower and their return to the beginning of the cycle of reaction in the Glover tower shows the recognition of their function. The newer or "contact process" of sulphuric acid manufacture is an illustration of another method of catalytic action, as here sulphur dioxide and oxygen are caused to form sulphuric anhydride by the catalytic action of finely divided platinum. That highly diluted sulphur dioxide such as found in the mixture of gases from pyrites burners could react in the presence of an active catalyst like platinized asbestos was clearly shown about 1898 and after that the success of the process was definitely settled, although many engineering difficulties had to be overcome. The chamber process operates more satisfactorily when monohydrate acid is desired, while the contact process is more suitable for the production of "oleum," or sulphuric acid containing dissolved SO_3.

The production of chlorine may be accomplished by the oxidation of hydrochloric acid in several ways, but in each case the reaction is a catalytic one. For the direct use of oxygen as a reagent to act upon hydrochloric acid gas a catalyst is necessary and in the Deacon process we have heated cuprous chloride used as such. The first action is supposed to be the formation of an oxychloride of copper which reacts with the hydrochloric acid gas to form cupric chloride, which is then decomposed by heat regenerating cuprous chloride and liberating chlorine.

The cuprous chloride catalyst is deposited upon broken clay bricks or upon pumice stone. Various other catalysts have been proposed as substitutes for the cuprous chloride, but it seems to be the most efficient in practice.

Weldon's process for the oxidation of hydrochloric acid in solution depends first upon the action of manganese dioxide as oxydizer whereby chlorine is liberated and manganous chloride is formed and then upon the effect of aeration at 50° to 60° C. upon the manganous chloride solution made alkaline by the addition of lime. The result is the precipitation of "Weldon mud," $CaO.2MnO_2$. This is then used under the name of "regenerated manganese dioxide" along with hydrochloric acid in the first stage of the process.

The greatly increased demand for hydrogen gas for industrial uses has led to the development of a number of catalytic processes for its production, some of which are in successful use. Thus in the presence of catalysts, steam and carbon monoxide (or water-gas containing carbon monoxide and hydrogen) react as follows:

$$H_2O + CO = H_2 + CO_2.$$

Oxides of the iron group are largely used as catalysts. Or lime may be used when the CO_2 produced is absorbed and a purer hydrogen remains. The liberation of hydrogen from liquid water acting upon iron at high heat under pressure is very notably improved by the presence of a small amount of ferrous chloride as a catalyst.

The synthesis of ammonia from the elements hydrogen and nitrogen under pressure in the presence of a catalyst, as accomplished by the Haber process, is one of the great industrial achievements of today. It was developed in Germany just before the outbreak of the war and the production in terms of sulphate of ammonia grew from about 20,000 tons in 1913 to about 500,000 tons in 1917. The process operates at temperatures between 500° and 600° C. and at high pressures. A great variety of catalysts have been used such as uranium, molybdenum and tungsten nitrides, but iron in a fine state of subdivision and made active by a small amount of a promotor is now used. The catalyst is easily poisoned by a trace of sulphur.

The process has also been independently tried and somewhat simplified by the General Chemical Company in this country.

The oxidation of ammonia in the presence of a simple catalyst may also be effected for the production of nitric acid, through the intervention of the oxides of nitrogen first produced, which react with water to form nitric acid. This was developed by Ostwald with the aid of a platinum catalyst, but iron with bismuth as a promotor has been found very effective.

A number of other promoters have been also used, but the important feature is to remove the oxides of nitrogen from the heated catalyst as quickly as possible, as they suffer decomposition very quickly at the temperature of their production.

The recovery of sulphur from alkali waste (CaS) by the Chance process also involves a catalytic process. The treatment of the alkali waste with carbon dioxide gas liberates a mixture of gases containing about 25 per cent. of hydrogen sulphide. This is decomposed with partial oxidation by passage with a current of air over heated oxide of iron as a catalyst at about 200° C. Water is formed and sulphur separates out and is carried along with the water vapor and condensed.

The removal of CS_2 impurity from coal gas by a catalytic reaction using metallic nickel as catalyst may be mentioned in passing as another valuable industrial application of catalytic methods.

ARTIFICIAL GRAPHITE. "The production of graphite from coke or anthracite on the manufacturing scale was successfully worked out by Acheson, to whom the possibility of the process was suggested by his previous work on carborundum (CSi). When a mixture of sand and coke is heated to a high temperature in an electric furnace, the carborundum produced is found to be surrounded by a certain quantity of graphite. Investigation showed that this graphite had been produced by decomposition of some of the carborundum, and that the conversion of amorphous carbon into graphite does not require the presence of sufficient silica to combine with all the carbon, but that a far smaller quantity is effective. Moreover, other oxides than silica, for example, ferric oxide, aluminum oxide, and boric oxide, are also active to varying degrees in bringing about the transformation.

"The action of these oxides is undoubtedly catalytic, and the most probable explanation of their mode of action is to be found in the assumption that carbides are formed as intermediate products.

When, at the high temperature of the furnace, the oxide has been reduced by the carbon the liberated metal forms a carbide, which subsequently decomposes, giving graphite. The metal then combines with more of the amorphous carbon, and the process continues until all the carbon present has been converted into graphite, when the metal volatilizes away. This explanation is supported by the fact that after all the amorphous carbon has been converted into graphite the charge can be almost completely freed from impurities by further heating.

"In making the finest qualities of lubricating graphite the raw material used is petroleum coke, which is mixed with 1 to 2 per cent. of ferric oxide as catalyst. Lower qualities are made from anthracite ground to small particles; in this case the silica, alumina, and ferric oxide naturally present in the anthracite are sufficient in quantity to catalyse the reaction."

CARBON TETRACHLORIDE. "At the ordinary temperature chlorine has little or no action on carbon disulphide, but if the latter contains a catalyst, or 'chlorine carrier,' such as iodine, antimony pentachloride, etc., a rapid reaction occurs which results in the formation of carbon tetrachloride and sulphur monochloride:

$$CS_2 + 3Cl_2 = CCl_4 + S_2Cl_2.$$

"The sulphur monochloride produced in this reaction can be caused to react with carbon disulphide in presence of a catalyst with formation of carbon tetrachloride and sulphur:

$$CS_2 + 2S_2Cl_2 = CCl_4 + 6S.$$

"The catalyst employed is a metal or metallic halide, preferably iron or ferric chloride. Excess of the chloride of sulphur is used, because then the reaction is rendered less violent and the yield is improved. The mixture of carbon disulphide and sulphur monochloride, with addition of the catalyst, is heated to about 60°, at which temperature the reaction begins, and when it is completed the liquid is heated to boiling for a short time. On cooling the sulphur separates in crystals; the liquid is fractionally distilled in order to separate the carbon tetrachloride from the excess of chloride of sulphur, and the crude tetrachloride is purified."

CYANIDE FORMATION. The fixation of atmospheric nitrogen in the form of a metallic cyanide is another important achievement based upon catalytic reactions. The recent work of Buchner can be noted as one of the best known processes for this end. Mixtures of alkaline carbonates and carbon with iron as catalyst are moulded into briquettes and heated in a current of nitrogen at a temperature of from 800° to 900° C. The process while successful on a small scale has met with many engineering difficulties and is not yet carried out on a continuous manufacturing scale.

Organic Catalytic Reactions Processes.

We made reference in the beginning of this account of catalysis to the early observations of the power of finely divided metals like platinum to condense the oxygen of the air upon their surface and so to bring about oxidation or combustion. The opposite effect or what we call "hydrogenation," consisting in the bringing of the element hydrogen into reaction, has in recent years developed an equal importance and is now the basis of great industrial applications.

From about 1897 on, Prof. Sabatier, of Toulouse, France, working with various helpers, has studied this particular problem with great success and pointed out its great possibilities. These are presented in a very complete and interesting form in his work, "Catalysis in Organic Chemistry," an English translation of which by Prof. Reid, of Johns Hopkins University has appeared.

HYDROGENATION OF FATS. The earlier attempts to hydrogenate oleic acid, using metallic nickel as catalyser, with the production of stearic acid were made with the material as vapor and were not commercially successful. With the German patent to Leprince and Siveke in 1902, and the corresponding English patent to Normann in 1903, which hydrogenated oils in the liquid state, began the practical work, although developed by numerous other subsequent patents.

The commercial and economic importance of these processes is seen when we consider that the soap industry requires solid fats in larger amount than is readily available and that the cheapest and most impure of the vegetable and animal oils may now be converted into pure solid fats. From the cheap fish and whale oils can also be produced by this treatment inodorous edible fats. The addition of less than 1 per cent. of hydrogen suffices to convert cottonseed or

other vegetable oil into a fatty body of at least the consistency of lard which product is odorless and very stable in character. So far as digestibility is concerned even whale oil appears to be fit for use as a food after being hardened. The iodine figure is cut down to a minimum indicating saturated compounds formed from unsaturated, while the specific gravity and melting point at the same time are raised. The only question that arises is the presence at times of traces of metallic nickel in the product, which may have some injurious effect, although that is as yet not established.

Catalytic Reactions With Naphthalene. By the catalytic hydrogenation of naphthalene first carried out by Sabatier and Senderens two very valuable solvents have been obtained, tetrahydronaphthalene and decahydronaphthalene known technically as "tetralin" and "decalin." These are no made on a large scale in Germany and have proved very excellent substitutes for turpentine and in addition have special solvent powers, dissolving both rubber and celluloid. They are produced by the hydrogenation with metallic nickel as catalyst. Extreme purity of the naphthalene is essential as the catalyst is readily made inactive by poisons.

On the other hand, the catalytic oxidation of napthalene is, if anything, even more important.

By oxidation of naphthalene with sulphuric acid at a temperature of over 200° C. and in the presence of a catalyst like mercuric sulphate, phthalic acid is formed. As this is a most important material used in the manufacture of artificial indigo as well as the basis of a class of important dye colors, the process is of great importance. It is stated in this connection that at 275° the addition of 1 per cent. of mercuric sulphate to the acid causes the reaction to proceed with a velocity five times greater than that attained where the catalyst is absent.

Another illustration of this reaction is found in the Kjeldahl method of oxidizing organic nitrogen compounds, for the quantitative estimation of nitrogen, by means of hot concentrated sulphuric acid, containing small quantities of mercury or of copper, or of the sulphates of those metals. The influence of the catalyst is very marked; thus it has been found that, at a temperature of 275° the addition of 0.5 per cent. of mercuric sulphate to the sulphuric acid increases the velocity of oxidation of aniline threefold. Moreover, in this case, as in many others, the acceleration produced by the

combined action of mercuric sulphate and cupric sulphate is greater than the sum of the accelerations brought about by each of these catalysts separately.

ACETALDEHYDE, ACETIC ACID AND ACETONE. A series of interesting and industrially important reactions, all catalytic in character, may be found starting with acetylene gas obtained from calcium carbide. The first reaction, that of hydration—

$$CH \div CH + H_2O = CH_3.CHO,$$

takes place when a current of acetylene is passed into an aqueous solution of an acid (like sulphuric or phosphoric) in the presence of a mercury salt, which acts as a catalyst and the acetaldehyde produced separated. Or acetic acid may be formed at once by the interaction of acetylene, oxygen and the requisite amount of water in the presence of salts of mercury such as the acetate, sulphate or phosphate.

The catalytic decomposition of acetic acid accomplished by distilling it through a heated tube containing barium carbonate with the production of acetone and carbon dioxide was proposed already in 1895 by the late Dr. Squibb and is very satisfactory, a yield of about 90 per cent. of the theoretical amount being obtained.

HYDROLYSIS. The whole class of decompositions of organic compounds grouped under this generic name has been shown almost without exception to be facilitated by the action of catalysts. We shall not attempt to cover this wide field at present, but take only a single class of compounds, *viz.*, the naturally occurring fats as an illustration of catalytic methods in their industrial treatment.

The hydrolysis of fats by water alone is possible although slow in practice. In the Tilghman process, a mixture of water and fat is forced through coils at a temperature of 300°; with superheated steam under a pressure up to 15 atmospheres it is more successful, but never complete.

With acid as catalyst, however, the hydrolysis is perfectly satisfactory. It may be accomplished with sulphuric acid (4 to 6 per cent. reckoned on the weight of the fat taken) with the production of a high per cent. of solid fat acids suitable for candle-making.

Still more satisfactory is the Twitchell process in which the

catalyst is a sulpho-aromatic fatty acid as naphthalene-sulpho-oleic acid. The process is operated at the ordinary pressure and can be carried out in open wooden tanks; 2 per cent. of the catalytic reagent suffices and the operation is completed in about an hour. The favorable results are due to the fact that the catalytic reagent is soluble both in the fat to be hydrolyzed and in the water. By thorough agitation with live steam a very perfect emulsion is therefore created, and in the presence of the strong aromatic sulphonic acid catalyst the reaction proceeds rapidly.

Saponification with alkaline catalysts. Lime or magnesia may be used as in the so-called autoclave process, using 12 to 14 per cent. by weight of the alkaline-earth catalysts, or caustic alkalies, as in the manufacture direct of soaps as the product of the reaction.

The reverse reaction to the hydrolysis of an ester like the glycerine esters of the fatty acids is the *esterification* of a mixture of an alcohol and an organic acid. This kind of reaction is also greatly influenced by the action of catalysts. An illustration will suffice for this. When two parts of ethyl alcohol containing 3 per cent. of hydrochloric acid are heated with one part of benzoic acid, the yield of ethyl benzoate amounts to about 75 per cent. of the theoretical quantity and again when a mixture of two parts of the alcohol one part of the acid, and 0.2 part of sulphuric acid is heated for some time a 90 per cent. yield of ester is obtained. Solid catalysts like thoria and titanium oxide have also been used successfully for esterification.

It would take much more time than is available to enumerate the many organic chemical industries in which catalysis plays an important part. We note only in passing the use of driers such as manganese and lead compounds with drying oils, the use of accelerants in the vulcanization of rubber and the use of special catalytic reagents like Grignard's organo-magnesium compound and Friedel and Craft's aluminum chloride reagent in organic syntheses.

Enzyme Reactions. We have already given an account of enzymes, the organic catalysts produced in animal or vegetable life. A great variety of these substances are recognized. We may simply classify the best known. First, Enzymes inducing hydrolysis, which in turn may be sub-divided into the following reactions: *Saccharoclastic* reactions, or those which hydrolize the carbohydrates; hy-

drolysis of the glucosides and glycerides (*lipoclastic*); and protein hydrolysis (*Proteoclastic* enzymes). Second, Enzymes inducing oxidation or reduction: the *oxydases* and the *reductases.*

Each of these classes and subdivisions includes a number of definitely recognized and effective enzymes, upon the action of some of which are founded important industries and in other cases important vital functions. Both the industrial organic and the physiological chemist have found abundant ground for study and productive results in this field and it is constantly expanding. We cannot, however, at this moment more than indicate its existence.

In conclusion, we would say that the literature of catalysis is already a considerable one and rapidly increasing. We would specially acknowledge our indebtedness for valuable information and suggestions to "Sabatier's Catalysis in Organic Chemistry," translated by Prof. Emmet Reid, to Rideal and Taylor's "Catalysis in Theory and Practice" and to Henderson's "Catalysis in Industrial Chemistry."

"THE ALUMINUM AGE."

By Ralph R. Foran.

(Assistant Professor of Technical Chemistry, Philadelphia College of Pharmacy and Science.)

[One of a Series of Popular Lectures Delivered at the Philadelphia College of Pharmacy and Science.]

Aluminum was discovered in 1827 by Wöhler, who isolated it in the form of an impure, gray powder, by decomposing aluminum chloride with metallic potassium. Later in 1845, he obtained the metal in small, metallic globules, by a modification of the same process. He made no further use of the discovery, except to determine the chief properties of the metal. It remained for H. St. Clair Deville, in 1854, to isolate the metal in an almost pure state, by decomposing aluminum chloride with metallic sodium. Under the patronage of Emperor Napoleon III he carried on research and in two years extracted fifty to sixty pounds of the metal, which sold for $260 a pound. The Emperor, a lavish spender, had a state coach, the bottom of which was made of solid aluminum. It is said

that this saved his life, for when a bomb was exploded under his carriage, although many bystanders were killed, he was protected by the metal bottom of the carriage and escaped unhurt. And so it seems that the money was, after all, well spent.

By 1878 the industry was well established in France, but the price was still high—about $13 a pound. About this time a works was started in England, but it was not until 1884 that manufacture began in the United States. Colonel William Frishmuth, who had a plant near the Richmond coal wharves in Philadelphia, turned out about 200 pounds in this and the following year. The aluminum cap or apex of the Washington Monument was cast by him. It weighed 8½ pounds and cost about $15 a pound—about as expensive as silver. Frishmuth's patented process was intended to be an improvement on the Deville method, but there seems to be a question whether he actually produced aluminum in commercial quantities by his method. Much of his output consisted of remelted scrap, obtained from abroad.

The Cowles Electric Smelting and Aluminum Company in 1886 was the first to use the electric furnace for the practical production of aluminum. Their process, however, yielded only alloys, containing up to 20 per cent. of aluminum. Their work was the first great advance in electro-metallurgy and showed the way for further improvement in the recovery of aluminum.

Among the workmen at the Cowles plant in Lockport, N. Y., was one Charles M. Hall, who, while a chemistry student at Oberlin College, had discovered the method which is used today universally. He found that bauxite or alumina, an oxide of aluminum and very plentiful, would dissolve in molten cryolite, a white mineral occurring in great quantities in Greenland. He also found when this solution was decomposed by the electric current, that he obtained aluminum. In the three years that Hall spent at the Cowles plant, he was unable to commercialize his process, but with the Pittsburgh Reduction Company at Niagara Falls he was more successful, so that in 1889 the output was 50 pounds a day. The price of the metal dropped to $4 a pound. This was due to the improved process and relatively cheap current furnished by the Niagara Power Company, which had just completed its first installation.

The year 1889 was truly epochal in the history of aluminum, for it was during this year that Hall's processes were patented, and that the Pittsburgh Reduction Company, later the Aluminum Company of America, started the manufacture of aluminum commercially.

In this same year, Héroult in France, patented a process, similar to the Hall method, which was and is still used abroad. Consequently the process of recovering aluminum by electrolyzing alumina in molten cryolite, is generally known as the Hall-Héroult process. Although the original patents have since expired, the metal is still obtained in much the same manner in all countries. Coincident with the progress in aluminum recovery has been the development of electric power, of which enormous quantities are necessary. In 1886, the Cowles Brothers had built a direct current generator of 30-horsepower capacity, which was called "The Colossus." Nowadays, this machine would be a pigmy as compared to the installations available for producing power.

With the impetus in production about this time, 1890, extravagant claims were made for aluminum. The pure metal had been the dream of chemists. Now that it was no longer rare, all sorts of uses were suggested. "Railway trains would be made imperishable and track wearage reduced to a minimum. Aerial navigation would be expedited. Military equipage, ammunition and guns would be lightened." The metal was popularly described as being "as strong as steel and but little heavier than wood." The presence of its ore in the earth's crust in large excess even of that of iron itself would furnish inexhaustible sources for the new Aluminum Age. A company was organized in Ohio for the purpose of manufacturing aluminum shoe soles. Although the metal is not now used for shoe soles, it is used for shoe heels. Solid aluminum bath tubs made their appearance, as did aluminum walking sticks and billiard cues. The Bryden Horse Shoe Company of Catasauqua, Pa., made aluminum racing shoes with a steel rim, weighing two ounces each, which sold for $1.25 a set. The manufacturers evidently were trying to satisfy the wants of the racing men who claimed that "an ounce off a horse's hoof is equal to a pound off his back."

The domestic price of aluminum in April, 1891, was $1.50 a pound. Later in the year this was reduced to 50 cents a pound, due

to the falling of the price abroad. Since then, except for a time during the World War, the price of the metal has never exceeded this figure—50 cents. It is now quoted at 22 to 23 cents a pound, in 50-ton lots.

As a matter of local interest, it might be mentioned that in 1893, the Tacony Iron and Metal Company of Philadelphia, contracted to deposit a coating of aluminum on the iron columns for the Philadelphia City Hall tower. The coating was for the purpose of preserving the iron from the action of the elements, aluminum being unaffected. Several years later the columns had lost their brightness and were eventually removed. Upon examination it was found that instead of aluminum, an alloy of aluminum and tin had been used. The late Professor J. W. Richards, in this year, strongly recommended that our cents should be made of aluminum. He said: "The advantages of light, clean aluminum over heavy, poisonous copper are self-evident." The United States Mint in 1865 had experimented in the making of aluminum coinage, but nothing ever materialized. During the war, aluminum coins were issued in France and Germany and even now in France, aluminum bronze coins are to replace the paper notes of small denomination.

Aluminum culinary utensils were first put on the market in 1893, by the Illinois Pure Aluminum Company, of Lemont, Ill. For cooking utensils, aluminum is the metal *par excellence*. It is light, easily cleaned, noncorrodible and its salts are non-poisonous. Weight for weight, it is not as good a conductor of heat as copper, although it has four times the heat conductivity of iron. Comparing an aluminum and a copper vessel of equal thickness, the aluminum vessel has the greater heat conductivity, which means, of course, a saving in fuel. At the present time, aluminum is worked into all manner of cooking utensils and culinary aids. The advertised brands of domestic aluminum ware are reliable and sold on guarantee, but there is an avalanche of worthless foreign and domestic ware on the market, "made to sell." Since 1919, Germany has increasingly flooded this country with every conceivable manner of aluminum ware, made from surplus war materal. Some of it is good, but most of it is cheap and not substantial. There is also much domestic ware of the same type.

As early as 1897, aluminum powder and leaf had replaced silver

powder and leaf, for many purposes. Today, aluminum foil is used, to replace lead and tin foil for wrapping candy, chewing gum, tea, tobacco, cheese, etc.

Count Zeppelin used aluminum in 1900, in his first airship and in the later and larger type, used during the war, each ship contained about nine tons of the metal and its alloys. The Zeppelin works at Staaken have within the last few years placed a motorboat on the market, made entirely of "duralumin," an alloy containing 94 per cent. aluminum, 4.5 per cent. copper and 0.5 per cent. magnesium. It is proposed to use such boats as lifeboats on ships.

On January 1, 1907, the Pittsburgh Reduction Company changed its name to the Aluminum Company of America, as more correctly indicating the nature of its business. From its organization in 1889, the company has enjoyed a monopoly of aluminum manufacture in this country. It turns out one-half of the world's production. The company started in 1889 with an authorized capital of $1,000,000 which had increased to $20,000,000 in 1916. Up to this time it had invested about $70,000,000 of undivided profits in its business. It is estimated that the present market value of the $20,000,000 capitalization is probably over $150,000,000. In 1906 it was predicted that with the expiration of the Hall patents, there would be "a battle royal between the the Aluminum Company of America and its new competitors." Nothing of this sort ever occurred. In 1908, an official of the company, appearing before the Ways and Means Committee in regard to tariff legislation, said that the then present price of 20 to 22 cents a pound was as low as aluminum could be manufactured under American conditions of manufacture. He also claimed that the position of the Aluminum Company of America was due, not to combinations, control of raw material, etc., but to meritorious patents. And yet in 1912, the United States Court in Pittsburgh entered a decree annulling alleged unlawful contracts of the Aluminum Company of America with the General Chemical Company, The Norton Company, the Pennsylvania Salt Manufacturing Company, Gustave A. Kruttschnitt and J. C. Coleman and forbidding the former company from participating in any combination or agreement to control the output or prices of aluminum. It was shown that the company had agreements with the first three companies mentioned, forbidding their engaging in the manufacture of aluminum or selling bauxite to any one else, and

with Gustave Kruttschnitt and J. C. Coleman, not to manufacture or sell aluminum east of Denver for twenty years from November 16, 1910.

In 1914, the Southern Aluminum Company, a subsidiary of L'Aluminum Francaise, with $6,000,000 capital, began building a plant at Badin, S. C. As a result of the European situation and financial difficulties, the plant was never completed and in 1915 it passed into the control of the Aluminum Company of America. The prospect of cheaper aluminum through domestic competition was not realized. And now the International Aluminum Company proposes to set up a plant at Nitro, W. Va., the site of the war-time smokeless powder development, using a process in which aluminum sulphate is electrolyzed in oleum. Some of the copper companies may enter the field, as aluminum is a dangerous competitor, both for alloy castings and electrical work.

While it is true that the Aluminum Company of America has never gouged the aluminum buying public, not even raising the price during the war, it is a monopoly—a word which brings to the mind of the average citizen, thoughts on trusts, business agreements in restraint of trade and the tariff. It is of interest to know that the price of aluminum in the United States has been increased in the past in about the same proportion as the duty on the foreign metal has been increased.

The use in cooking utensils is one of the mainstays of the business, but large quantities of aluminum and its alloys are used for many other purposes. The automobile industry uses millions of pounds annually and who knows but that Henry Ford wanted Muscle Shoals whereat to produce the aluminum for his "Featherweight Flivver." And at that, the aluminum automobile is not a theory. Experimental cars have demonstrated that the durability can still be maintained with a great saving in weight and an increased mileage. The problem of a diminishing gasoline supply will hasten the coming of the lightweight aluminum car.

Substantially one-third of the Liberty motor was aluminum. It was used wherever possible—engine beds, crank cases, pistons, oil pumps, camshaft housings, etc. It was also used for the gasoline tank, fuselage, hood, cowling and seat backs. The all-metal planes would be impossible without aluminum. Fabric wing coverings are

replaced by duralumin. The framework is tubing of the same alloy.

The war uses of aluminum and its alloys were many and varied. The Germans used much aluminum as a substitute for copper, even for dynamo windings. Until the beginning of the war, no aluminum was produced in Germany, although a great many aluminum products were manufactured there from metal imported from Switzerland. The French used an aluminum alloy for helmets and all of the armies used the metal in mess equipment and for many other purposes to which its lightness adapted it. Every American soldier wore at all times identification tags of aluminum and his trusty gas mask contained parts made of this metal.

The metal is finding increasing use as an electrical conductor. Although for the same thickness of wire it has only about 60 per cent. of the electrical conductivity of copper, taken weight for weight it is a better conductor. It is used mainly in the West and South for electrical transmission lines and in the manner used has 80 per cent. of the weight of copper cable of equal conductance and is 57 per cent. stronger. There are lengths of cable up to 275 miles in use, carrying up to 150,000 volts. In 1913, 15 per cent. of the output of aluminum was used for transmission cables.

For the future, the alloys of aluminum promise most perhaps. Alloys of the type of duralumin and magnalium are being used increasingly. In the last few years a great deal of research has been carried on in this country and abroad, with the end in view of defining those alloys which are at once light in weight, strong and noncorrodible.

In closing, a little introspection might not be out of place. Aluminum is one and one-half times more plentiful than iron and four thousand times more plentiful than copper. Iron and copper were both known to the ancients. Aluminum has been known only ninety-six years and in common use for only thirty-three years. Professor Richards hazarded the thought that it would surpass lead in 1930 and zinc in 1940, and both of these metals were discovered in prehistoric days. It is conceded that, in the light of its peculiar properties and manifold applications, it is exceeded only by iron and copper. That it will surpass copper within the next fifty years is not a rash estimate. It will then be next in importance to iron. And then what?

PETROLEUM—A SHORT STORY.[1]

By J. Norman Taylor, M. S.[2]

Petroleum and its products are in greater use today than at any other time in the world's history. When we consider that at present there are in the United States alone over twelve million motor cars, hundreds of thousands of motorboats, to say nothing of a steadily increasing number of motorcycles, trucks, air-craft, tractors, and stationary and other internal-combustion engines depending for their usefulness upon gasoline, kerosene and lubricating oils, the necessity of insuring an adequate supply of petroleum for the nation's needs is obvious. Then, too, the "Iron Man" in his rapid replacement of human labor in industry depends for his very existence upon lubricants. Another petroleum product, fuel oil, is being consumed in increasing quantities both upon land and on the sea. Yet, while the demand for petroleum and its products is growing, the supply of crude oil in this country is being rapidly repleted. No wonder that our statesmen and scientists are searching for a solution of the oil problem—a situation that can only be relieved by finding new supplies, eliminating waste, and adopting improved methods in refining processes.

The increasing importance of this commodity in our national economy makes the story of petroleum a most interesting one indeed, not only to those who are pursuing the study of chemistry and the allied sciences, but to all who have contact with modern civilization.[3]

Petroleum is a complex mixture of hydrocarbons varying in physical state from solid to gaseous and in color from coal-black, through brown, greenish, red and yellow, to colorless. The chemical nature of its constituents varies with the locality in which it is found, the chain bodies predominating.

Although the petroleum industry of the United States, as we

[1] This article is based upon a paper presented before the Chemical Society of George Washington University.

[2] Instructor in chemistry at the Washington Preparatory School and at George Washington University.

[3] The economic treatment of this subject is admirably made in the *Atlantic Monthly* for February, 1923, in an article entitled "Civilization and Oil," by Leo Pasvolsky, the economist.

know it today, is of comparatively recent origin the crude oil has been known from the earliest historical period and in this country had undoubtedly been long used by the Indians.

It occurs in rocks of all ages, "from the lower Silurian to the most recent" (Merrill), and as a rule in sandstone formations. Occasionally it is found in limestones and shales. Geologic relations indicate petroleum to be of organic origin—a product derived from the slow physical and chemical alteration of ancient deposits of vegetable and animal material under the influence of heat and pressure.

For convenience, the sources of petroleum in the United States may be classified as follows:

The Appalachian field (centering in Pennsylvania), the Lima-Indiana field (in Indiana and Ohio), the Illinois field, the midcontinent field (centering in Oklahoma), the Gulf coast field (in south Texas and Louisiana), the Colorado-Wyoming field, and the California field. In the midcontinent field lie various pools, groups of pools, or districts, the distinguished ones being called the Cushing pool (Oklahoma), the Healdton pool (Oklahoma), the Caddo district (northwestern Louisiana), and the north Texas district.

There are about as many varieties of crude petroleum as there are oil fields. However, the refiner recognizes three distinct types, noted below, each of which must be handled by different methods. The paraffin base crude similar to that found in Pennsylvania and West Virginia is essentially a light-colored crude containing paraffin; the asphalt base crude, similar to that found in Texas and California, contains no paraffin and is generally dark colored, almost black; mixed base crudes, similar to those found from Ohio to Oklahoma, are essentially mixtures of paraffin and asphalt base crudes. California oils contain nitrogen and ring compounds.

Professor Charles E. Munroe in his well-known monograph on "Petroleum Refining" states that it is not surprising that petroleum obtained in Texas, California and Ohio should differ in appearance and properties from each other and from the better known Pennsylvania oil and from that obtained from other parts of the country. He attributes this difference in appearance not only to the fact that petroleum consists of a mixture of various hydrocarbons from different acyclic and cyclic series and of hydrocarbon derivatives containing sulphur or oxygen or nitrogen or other elements which

themselves differ widely in properties and appearance, but also to the varying conditions under which the petroleum is produced and to the effect due to migration.

Crude petroleum has a limited application and owes its great value to the products derived from it. It is, therefore, treated at the point of origin or is transported to an industrial centre by tank car, tank ship, barge, or pipe line. This latter mode of carriage is remarkable for its ingenuity and we have today the remarkable achievement whereby vast quantities of oil are made to flow under rivers and through mountains to great refineries on the seaboard such as are found at Philadelphia, Bayonne and Baltimore. Upon arrival at its destination the crude oil is freed from water and other sediment by allowing it to settle in storage tanks, after which it is pumped into retorts where it is submitted to fractional distillation.

This operation depends upon the principle that different liquids, at the same pressure, have different boiling points. The mixture of various hydrocarbons when submitted to gradually increasing temperature might be supposed to assume the vapor condition at the temperature of their respective boiling points and upon condensation, the individual constituents of the petroleum would be in their pure state. But such simple conditions do not obtain, since the boiling points of mixtures vary inversely as the vapor pressures. Although the composition of the vapor given off from such mixtures bears no close relation to the composition of the mixture, the vapor contains a preponderating amount of the most volatile constituent. Hence it is to be expected that when the crude oil is subjected to gradually increasing heat, the constituents are successively converted into vapor substantially in the order of their volatilities, but that the separation thus effected would not be perfect, as the oils of the higher boiling points are to some extent carried over by the vapor of those of lower boiling points.

It is evident from this that difficulties arise in the distillation of petroleum attributable to one or other of three causes: (a) to the presence of two substances, the boiling points of which are very close together; (b) to the presence of one or more components relatively in very small quantity; (c) to the formation of mixtures of constant boiling point. These difficulties have to a great extent been obviated by the use of dephlegmators similar to the Hempel column,

in which the dephlegmating column consists of a drum filled with cobble stones, surmounted by a number of tubes. A large surface is thus presented and a more complete separation of the constituents of the crude obtained.

The distillation retorts, known as stills, are of cylindrical form constructed of boiler plate and are set horizontally in brick work furnaces arranged in batteries. Stills surmounted by dephlegmators such as described above are known as "tower stills." Upon the application of heat the crude oil is converted into vapor and the vaporized oil upon passing into the condensers is thus brought into the liquid condition. In practice it is usual to divide the distillation into two operations, the more volatile products, naphtha and kerosene, being obtained in the first part and the residue being transferred to the tar stills and heated to a higher temperature with the object of separating the lubricating oils and paraffin. By the use of "tower stills" the entire distillation may be conducted without transfer to the tar stills, as the tower is supplied with three traps, from the first of which may be collected heavy distillate, intermediate distillate from the second and light distillate from the third, and the still run to "maltha" or coke as desired. The streams of distillate are from time to time diverted into various tanks by the stillman. When the still temperature reaches about 325° F., the crude naphtha ceases to come over, and the stream is directed into the lamp oil tank. When that portion of the oil from which the high test oils of 120° to 150° F. fire test are prepared, is distilled off (the still temperature being about 600° F.), the fires are slackened and if it is desired to produce a maximum amount of light products in preference to a maximum amount of the heavy lubricating oils and petroleum asphalts, the "cracking" process will be used.

The "cracking" process, whereby a considerable quantity of the oil which is intermediate between kerosene and lubricating oil is converted into hydrocarbons of lower density and boiling points, is one of great scientific and technical interest. This dissociation into simpler molecules may be brought about by pyrolytic distillation and, unless a catalytic agent is used, is due to super-heating of the boiling liquid. A considerable number of processes have been brought forward for effecting the transformation of heavier hydrocarbons into gasoline hydrocarbons, the most widely used one being that of Dr. Burton, in which the pressure which obtains is greater than the

atmospheric pressure. Other processes operate at atmospheric pressure and some, as in the McAfee patent, use a catalytic material such as anhydrous aluminum chloride.

The products obtained on separating petroleum into its commercial fractions are usually purified by treatment successively with sulphuric acid and ammonia or soda, the lightest distillates being treated with about 5 per cent. by volume of the concentrated acid and the intermediate distillates with about 1.5 per cent. The treatments with acid and with alkali are conducted in agitators lined with lead and provided with an air blast and outlets for the spent chemicals and treated oils. These agitators hold from 50,000 to 150,000 gallons of oil at one charge. Concentrated sulphuric acid is thoroughly mixed with the oil by means of the air blast and after settling, the acid sludge is drawn off, the oil washed with water, then with alkali and finally brightened with fuller's earth. This treatment improves the color and odor of the oil, and removes the aromatic and unsaturated hydrocarbons, phenols, tarry products, and other substances which lower its quality.

The acid sludge is diluted with water to separate the oil dissolved in it and usually is treated to regain the acid used in the manufacture of fertilizers or it is concentrated for re-use in the refinery. The oil which separates on treating this acid sludge is called "acid oil," and is, after appropriate treatment, used to some extent as a substitute for ichthyol.

Oils high in sulphur, like the Ohio oils, receive a special treatment devised by Frasch. The first distillation is conducted in the ordinary way, and the distillate subsequently pumped into another still provided with a mechanical stirrer and redistilled in the presence of an excess of finely divided oxide of copper, the contents being kept thoroughly mixed by the revolving apparatus. The second distillate is practically free from sulphur and is treated in the usual way with acid and alkali. The residue in the still, consisting of a mixture of tar and copper oxide, is drained and pressed and the pressed copper compound is revivified through roasting and used over again.

The residue from the kerosene distillation is worked up into lubricating oil and paraffin by distilling with superheated steam to prevent dissociation of the hydrocarbons. This steam distillate is then treated with successive portions of sulphuric acid and of alkali,

then cooled by passing through a tubular cooler, when the paraffin crystallizes out and is separated from the oil by means of filter presses. Both the lubricating oil and paraffin are further refined by filtering through fuller's earth or animal charcoal.

Petrolatum (known also as cosmoline and vaseline) is obtained by the careful distillation of selected grade petroleum carried on in vacuum stills. Liquid petrolatum may be prepared from the lubricating oil fraction of certain oils and is composed essentially of the naphthene hydrocarbons.

A large number of physical and chemical tests are applied to the raw materials and manufactured products. The determination of the specific gravity is one of the tests that is considered important in every product from the lightest to the heaviest. This is generally determined by means of the hydrometer and is expressed in degrees Baumé.

The specific gravity and range of boiling points are the tests chiefly applied to the light petroleum products, some of which are commercial "pentane," used extensively as a standard of light in photometric work; petroleum ether and ligroin, both of which are used as solvents for fats, oils, waxes, and certain resins; 76° gasoline; deodorized naphtha; stove naphtha; varnish makers' and painters' naphtha, and motor spirit. The boiling point limits of these light products are being extended from time to time, so that it is impossible to define them accurately.

Kerosene is examined as to color, odor, flash point and fire test, as well as to burning quality, viscosity, composition (as ascertained by fractional distillation) and sulphur content. The flash point is determined for the purpose of ascertaining the inflammability of the oil. There are several instruments in use for this determination, chief among them being the Abel tester, Saybolt's electric tester, Tagliabue's open and closed cups, the Elliott cup, and the Bureau of Mines tester.

Lubricating oils are of great variety and the requirements vary with the purpose for which they are used. All should have high burning points. Viscosity is the most important index in evaluating a lubricating oil and for those used in internal-combustion engines the "carbonizing number" is a valuable consideration. The "chill," or temperature at which solid hydrocarbons are deposited, is also important.

Petrolatum and paraffin are examined principally for their melting points. Petrolatum is used extensively as a basis for ointments. Liquid petrolatum is used as a laxative and as a vehicle for substances used in the treatment of mucous membranes. Paraffin is used for a number of purposes, as in the arts and in the manufacture of candles, and is sold in several grades. The tarry residual products, certain types of which are sometimes called "maltha," are used extensively in road building. Petroleum coke is used for fuel, but since it contains very little ash and much "fixed carbon," it is used more extensively in the manufacture of electric light carbons.

These are but a few of the products which petroleum is furnishing us today. Upon the establishment of this industry only a few generations ago the main product was illuminating oil and remained so for three decades. Materials, such as gasoline, fuel oil and lubricating oils, which were then considered as by-products—in the sense that by-products are defined by Professor Munroe, namely as "substances or results obtained in the operation of a specific process in addition to the result mainly sought,"—have since risen to the rank of main products. Today, petroleum by-products are counted by the hundreds and are increasing in number and in importance and it seems quite likely that the romance of the coal-tar derivatives industry will, in the not-distant future, be paralleled by a great chemical industry having its basis in petroleum.

DUST.*

By Edward J. Hughes, P. D.

There is a passage in the Scriptures that reads: "Dust thou art and unto dust shalt thou return." No words can be more significant than these regarding the origin and the destination of our material bodies. It is difficult to imagine what a world without dust would be like since we are constantly submerged in a sea of dust out of which there is apparently no escape.

It can be shown that the dust that we are so apt to look upon as a nuisance gives to the world much of its beauty, its profit and its health as well as its waste, its sickness and its tragedy.

*Read at the March meeting of the Faculty of the Philadelphia College of Pharmacy and Science.

Dust is ordinarily understood to be fine particles of matter which float on currents of air and settle on surrounding objects. These minute particles consist of sand, cotton fibre, soot, pollen, fine hair, bacteria, molds, parts of seeds, etc. The atmosphere of cities may, of course, contain many other kinds of particles, depending upon local conditions and upon the nature of the material being discharged into the air. In other words, the atmosphere presents to us a world which is teeming with myriad hosts of tiny objects too small to be seen with the naked eye and thus beyond our ordinary powers of perception.

Let us see how this concerns us! Scientists have found that the blue color that is observed in a clear sky is due to the refraction of sunlight by the dust particles. We are also told that without these suspended dust particles the gorgeous color effects that are so often enjoyed at dawn and at sunset would never be observed. In other words there would be no haze, no twilight, none of the beautiful atmospheric effects that are so delightful to the eye. The clouds owe their origin to dust since Aitken has shown that when water vapor condenses in the atmosphere it always does so on some solid nucleus as a dust particle, without which there could be no fogs, clouds, mist or rain.

The processes of putrefaction and decay due to the living organisms in the air are examples showing that the dust of the air contains an invisible world of life. Most forms of so-called spontaneous fermentation, which were at one time believed to originate from non-living material, were shown by Pasteur to be caused by the living dust of the air.

The development of a large portion of the plant kingdom is promoted by pollen dust that is carried about from plant to plant by the wind. This constitutes one of the methods of cross-fertilization. It seems indeed probable that some of the new plants found by explorers on oceanic islands are hybrids that owe their origin to pollen carried from the main land by the prevailing winds; the nature of these winds obviously preventing the passage of pollen in the opposite direction.

The dust of cities especially has proven to be a most serious menace to public health. Not only are disease-producing bacteria carried about in the dust, but it has also been found that when an individual breathes in an atmosphere containing an abnormally low

amount of moisture the dust generally causes an irritation of the mucous membranes, a condition under which the pathogenic organisms are very apt to take hold and flourish.

Dust is present everywhere, though the quantity of dust at different places may vary in degree. The popular fallacy that the sun shining into a room raises the dust is an error coming from the principle, "Out of sight, out of mind." The dust becomes visible in a beam of light because there is diffraction of the rays of light and the dust particles appear to be larger than they really are.

Man is now able to control and to utilize with profit many of the special forms of dust that were once rejected as waste material. For example, coal dust is now being used in special forms of burners wherein a regulated supply of the powdered coal is sprayed along with a blast of air into the combustion chamber. Coal dust is also being compressed into briquettes, with the aid of an oil binder, the product being quite as satisfactory as any regular stove coal could be.

Arsenic dust has been a decided nuisance in localities where smelters were extracting some of the metals from their natural ores. Nowadays the fumes which gave rise to the arsenic dust are being condensed and what was once a dangerous waste product is now a source of valuable arsenic compounds that find their way into pigments, insecticides and medicines. Ore dust is now being recovered, shaped into larger masses or briquettes and is used over again with the natural ore in the extraction of the metal. The cement industry reports the recovery of large quantities of potassium compounds from the dust given off by cement kilns. Cork dust, a by-product in the manufacture of corks, is being used in the production of high grade linoleums. The term wood alcohol generally applies to methyl alcohol and yet ethyl alcohol can be made from wood, since sawdust can be heated with steam, under pressure, in the presence of diluted sulphuric acid with the production of a fermentable sugar, which is subsequently decomposed into alcohol and carbon dioxide. These are only some of the things that are being done with dust in order to reduce flagrant waste and to increase industrial efficiency.

We have learned that dust can be violently destructive to human life and property. Dust explosions, or explosions of air-suspended dust, are frequently being recorded. Such disasters generally occur in grain elevators where a heavy dust-laden atmosphere becomes

ignited at a certain point, the ignition being immediately transmitted to the other dust particles, with explosive violence.

The dust that is encountered in many of the occupations of man often proves to be insidiously dangerous. The coal miners' lungs blacken with a lining of coal dust; the masons' lungs become lined with fine dust from the scrapings of stone; needle-grinders choke with steel from the grindstone and nearly every one is familiar with the frequent cases of poisoning from the white lead works.

One cannot leave a consideration of dust without reflecting upon the ultimate interdependence of things. The dust that forms in the decay of the animal body, after being carried about by the wind, settles in the soil, where it fosters the growth of the wheat and the rose.

Man's body, created out of the dust of the earth and nourished in a dust-laden atmosphere by the products of dust, finally mingles with the dust whence it came.

Thus we observe how dust is involved in the wonderful cycle of life. As Lord Lytton has said:

"There is no death! The dust we tread
Shall change beneath the summer showers
To golden grain or mellowed fruit
Or rainbow tinted flowers."

ABSTRACTED AND REPRINTED ARTICLES

THE EARLIEST APPARATUS AND PROCEDURES OF PHOTOGRAPHY: CONTRIBUTIONS TO THE CENTENARY OF MODERN PHOTOGRAPHIC METHODS.*

By Henry Leffmann, A. M., M. D.
(Lecturer on Research, Philadelphia College of Pharmacy and Science.)

In 1889 a semi-centennial celebration of the invention of photography was held, especially under the auspices of French pho-

*Presented at a joint meeting of the Sections of Physics and Chemistry and Photography and Microscopy, held Thursday, December 14, 1922. (From *Jour. Frank. Inst.* 1923, *195*, 327.)

tographers, the date relating to the formal announcement by Arago (before the French Academy of Sciences) of Daguerre's method of taking pictures. It is proposed to celebrate in 1923 a *centennial* anniversary, and the question at once arises as to what has become of the sixteen years that should elapse before the centenary of Daguerre's invention will occur. The answer is that while Daguerre perfected a method of taking portraits with the camera after comparatively short exposure, the first actual picture-making by means of light was done by Nicephore Niépce about 1823. It is the centennial of this procedure that France has decided to distinguish.

No such celebration can occur without raising the question of the early history of the procedure and causing disputes as to priority, but the moment the investigator begins to search the records confusion arises. What constitutes discovery or invention? Aristotle and Augustine make allusions that can be interpreted as indicating a theory of evolution, yet they are not quoted as real anticipators of Darwin and Wallace. Scattered through the writings of scientists from the thirteenth century on to the close of the seventeenth, we find more or less incidental allusions to the property of silver salts blackening in contact with organic matter, but the effect was not infrequently ascribed to the action of the air. We should not, however, deal flippantly with such mistakes, for we may note that even as late as the early part of the nineteenth century, when the natural and physical sciences had reached a high degree of exactness, the yellow tinge seen in common flames was ascribed to the presence of water. It is now known to be due to sodium salts. The names of Albertus Magnus, Roger Bacon, Fabricius, Glauber and, of course, Leonardo da Vinci, would be mentioned in a summary of these adumbrations, but the data at hand seem to show that the first one to recognize the cause of the blackening of silver salts was Heinrich Schulze, who in 1727 demonstrated the action of light upon a mixture of chalk and silver nitrate, essentially silver carbonate. The mixture was prepared in a glass vessel, a part of which was covered by paper. On exposing to light the precipitate darkened at the unprotected places, but was not affected at the other points. By this means it was shown that the action was not due to either air or heat. It is obvious that, interesting and creditable as Schulze's experiments are, they are not photography in the sense in which the word is understood today. An important point is that the results

could not be fixed, that is, the effect of the light could not be stopped after the action had gone as far as desired, unless the material was kept in the dark. It is also to be noted that the effects are merely copying; there is no formation of an image of an external object. All modern procedures are the results of invention and discovery along several independent lines. Whether we take instruments of research, such as the telescope and microscope, apparatus for manufacturing, such as the printing press, for transportation, such as the locomotive, or for amusment, such as the motion-picture, we will find them culminations of the labors of many workers. The motion-picture, for instance, depends upon a brilliant light source, a flexible film, a high-speed emulsion, excellent lenses, active developing and fixing materials and mechanical appliances. So in modern photography, many have had a share in the progress, and it is difficult and even invidious to give the honors to a few. The bridge built some years ago over the Susquehanna, at Havre de Grace, bore a tablet stating that it was the work of "a thousand men for four years," and similarly our modern photographic procedures may be described as the work of hundreds of investigators for several centuries.

Pinhole Photograph.

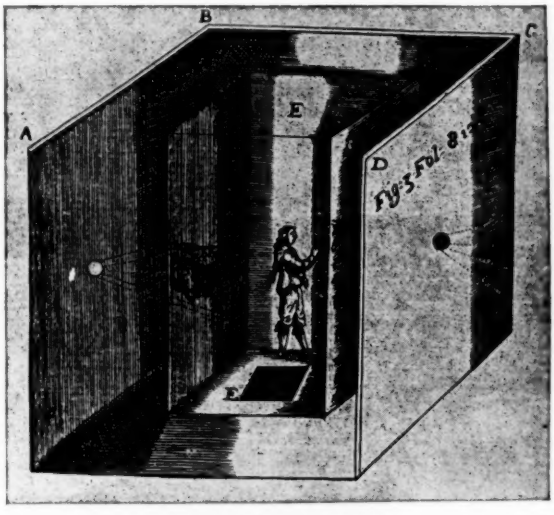
Courtesy of The Franklin Institute.

Light has wide range of action; few substances, if any, are wholly immune, but in most cases the changes are but slowly pro-

duced and very slight. A few substances show great susceptibility, the silver salts being, so far as ascertained, pre-eminent in this repect. In modern photography, therefore, silver dominates, and it is especially the chloride, bromide and iodide that are employed, these being conveniently included under the title "silver halides." Light produces a prompt visible effect upon silver chloride, which is darkened, but the other halides show no visible effect except upon prolonged exposure. Notwithstanding this lack of change in appearance, it is easily shown that even exceedingly brief exposures of silver bromide or iodide produce a marked change, which can be demonstrated by the precipitation of silver and some other metals—upon the parts that have been touched by the light. It has been a question whether the light acts by producing chemical decomposition or merely changes the substances physically. Considerable investigation has been carried out to determine this point. For convenience, the area of the halide affected invisibly by the light is called the "latent image." Two views as to the chemistry of the latent image are now in vogue. One is that sub-halides are formed by action of the light; the other is that a complete decomposition of a limited number of molecules takes place and that the silver thus set free is in colloidal condition. Under either theory it seems reasonable to assume that a difference of electric potential will be produced, respectively, in the parts touched and not touched by the light, and as the subsequent production of the image by development is due to the precipitation of metallic silver, a selective attraction will be the result. It is, however, not within the scope of this paper to discuss the problem to any extent. Some salts of mercury and copper are distinctly sensitive to light, although not nearly so much as the silver halides. Mercurous iodide, which is a bright yellow powder, undergoes, with moderate rapidity when exposed to a strong light, a conversion into a black powder. Presumably, this effect is due to the separation of metallic mercury in a state of fine division, in which its familiar lustre is lost. This property of mercurous iodide was studied in 1836 by Artus (*J. prak. Chem.*, 1836, viii, 63). In many cases the effect of light can be increased, in extent or rapidity, by the addition of a third substance, which may be unaffected, thus acting the part of catalyst, or may take definite part by combining with the liberated element, thus preventing a saturation or equilibrium, which would interfere with further action. It is now well known that many rays of light are invisible to the human eye,

but have active chemical and physical effects. Rays that are beyond the violet, which is the upper limit of the visible spectrum, have a powerful effect on silver salts.

The sensibility of silver salts to light would have had but a narrow field of application if it was not possible to project the image of any object in correct form upon a sensitized surface. That is, some optical arrangement must be employed. Schulze secured a contrast between light and darkness, but he constructed the picture—at least, we may for sake of argument call it a picture—and devised no method by which a natural object or design could be repeated on his mixture of chalk and silver nitrate. Niépce also copied designs by superposition. Other workers, especially Davy and Wedgewood in England, made experiments along these lines. They employed different materials coated with silver nitrate which blackened under the light, but such changes are too slow, even if apparatus was available, and moreover, as noted above, the prints could be preserved only in the dark.



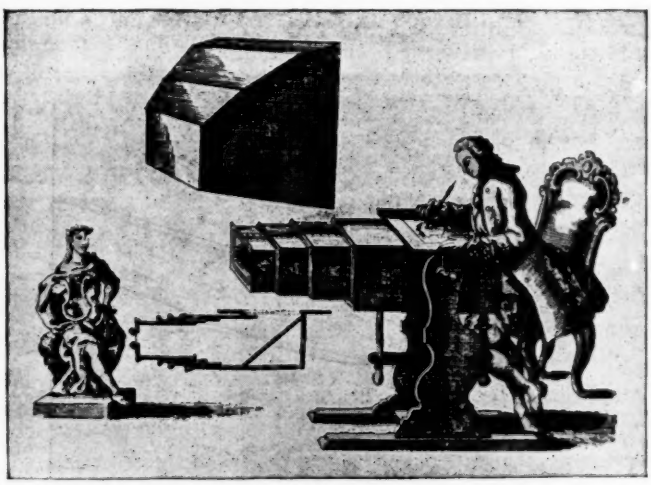
Kircher's Camera (1671).

Courtesy of The Franklin Institute.

The invention of the camera is a most important phase of the development of photography. The word goes back to a Greek word, "kamara," meaning anything with a vaulted or arched cover.

It came to mean "room," especially a vaulted room, and after suffering several etymologic evolutions it has become the regular term for room in several European languages. It is the familiar instrument in all departments of photography, and probably as much mechanical ingenuity has been applied to it as to any other machine. The evolution of it from the clumsy, heavy and expensive form of Daguerre's day to the "push the button and we do the rest" of the modern amateur, would require pages to detail. Coincident with the evolution of the form of the camera itself, has gone the improvement in the lens, extending its field, improving its definition and increasing its speed.

The camera is an invention of several centuries ago. It is usually ascribed to an Italian, John Baptist della Porta, but some doubt exists as to how far he actually originated it. He developed the apparatus a great deal, and described it in a work in several



Early Camera Lucida.

Courtesy of The Franklin Institute.

volumes, which appeared during the years 1558-1589. This work was translated into several languages, an English edition appeared about a century after the original text. The title "camera obscura" refers to the fact that the room was dark except so far as it was illuminated by the image transmitted through a lens. The modern camera in all its forms can be traced back to the apparatus della

Porta described, but the formation of images is not dependent on a lens. A minute opening is capable of forming a complete picture, indeed the perspective is better than that obtained with almost any lens. To obtain a perfect image in this way, the opening should be so small as to admit only single rays of light from all points, a condition that is not capable of being realized in practice. The opening, therefore, gives a slightly confused image, but this is no objection in landscape and architectural photography. In practice an opening about large enough to pass a small needle is made through a metal plate, quite thin at the point of perforation. Care must be taken that no bur is present; the metal must be perfectly flush on each side. Such an arrangement is usually termed a "pinhole." Pinhole pictures have been made by many workers, and according to Eder (*Geschichte der Photographie*) a precise description of such a method of projecting images of external objects was first given by Leonardo da Vinci, who stated that when a building or a landscape is brilliantly illuminated by the sun, an inverted image can be obtained by means of a small perforation in the wall of an opposite building. He states that the opening should be very small and neat, and further that the formation of the image is akin to the formation of the image on the retina, the pupil acting as the opening. It is a remarkable anticipation of the pinhole method, but it must not be overlooked that the eye acts by means of its lens system, and that the pupil opening is too great to form a clear image on the retina. These discoveries of Leonardo were doomed, like many that he made, to be practically fruitless, being locked up in his writings, difficult to read and long deferred in publication. It is, therefore, not possible to say how far some of the later workers in this field owe their inventions and discoveries to accidental knowledge of Leonardo's work or made independent developments.

As noted above, pinhole pictures give better perspective than lenses, and are especially suitable for architectural subjects and some classes of landscapes. The exposure is long, being ordinarily sixty times that required with a rapid lens, so that if a given combination will give a good picture with one second exposure, a pinhole substituted for the lens will entail a one-minute period. Moving objects, unless quite slow, are not taken, so that a pinhole camera may be employed on the side of a road over which automobiles are passing without appreciable record of these. The picture also has a softness which is not usual with those made with lenses, although modern ex-

pedients are now available by which extreme softness may be obtained by the standard cameras. These extreme degrees may be imitated to a limited extent by using a pinhole of larger diameter, but no particular advantage is gained. The minute opening is, of course, unsuited for photomicrography, in which microscopic sharpness is required.

Investigation has been carried on with great earnestness since the days of Daguerre, for his procedure made photography of wide practical value, and many methods of procedure have been devised. The daguerreotype, though highly artistic, has the disadvantage that each picture required a separate sitting, and the same was true of the ambrotype, which was made by producing a thin negative on

Stereoscopic Drawings (Supposed Fourteenth Century).

Courtesy of The Franklin Institute.

glass and then mounting this with a black backing. The invention of the paper positive gave at once the most desired feature to picture-making, namely, the ability to produce any number of positives from one exposure. Subsequently the wet collodion process which was an early method of making glass negatives was applied to the ferrotype or "tin-type," as it was familiarly called. In this a sensitized collodion film was spread on lacquered sheet iron, and when developed and fixed gave a pleasing portrait. In this, as in the daguerreotype, each picture required a separate sitting, but this difficulty was overcome during the vogue of the method, by multiple lenses, such as four in a group, and a sliding arrangement by which four exposures could be made on one sheet, thus obtaining sixteen

pictures. It is not necessary to follow the details of commercial photographic development as the principal features are well and generally known.

The introduction of desensitizers is an important and very recent feature of photography. As in all other cases, the existing methods were in a way anticipated, for many years ago it was shown that the ferrous oxalate developer diminishes materially the sensitiveness of the ordinary dry-plate emulsion, so that the development may be carried out in a brighter light than usual, but this method did not come into practical use. A couple of years ago, Lüppo-Cramer, a Münich chemist, discovered, as a result of trials of many substances, that a dyestuff known as "phenosafranin," had power to diminish the sensitiveness of the common emulsions, without appreciably diminishing the latent image, that is, the undeveloped impression on the plate. A solution of 1 gram to 1000 cc. (15 grains to the 1 quart) will serve for many plates. After exposure, the plate is immersed for a couple of minutes in the solution (in darkness, of course), briefly washed, and immersed in the developer. The immersion in the dye so far abates the sensitiveness, that plates that require green light can be safely developed by the ordinary red light, and those requiring red light can be developed in yellow. The plate is stained, but this can be removed by washing or by certain chemicals. In most cases the stain does not interfere seriously with the use of the negative. The solution stains the hands, and it is well, therefore, to use rubber finger cots. After the plate is fixed and washed there is no danger of staining the hands. Lumière and Seyewitz made many experiments with a view of discovering substitutes for phenosafranin, but found little of importance. A yellow dye, "aurantia," was found to have marked desensitizing power, but has no special advantage. Lüppo-Cramer published the composition of the desensitizer, with the result that it was introduced into commerce in other countries under trade names, and the inventor deprived of both honor and profit of his discovery. He has since introduced two new dyes, the composition of which he has not made known, designating them simply as "pinakryptol" and "pinakryptol green," respectively.

A remarkable modification of photographic procedure is developing after fixing. Several methods have been long known, but none has special practical value. It is of considerable theoretical interest inasmuch as it has a bearing on the nature of the latent

image, for by means of a weak fixing bath, all the sensitive emulsion can be removed, as far as can be judged by the eye, yet after washing thoroughly in order to get rid of the soluble salts, the image can be brought out fully by means of several forms of developer, among the simplest of which is a solution containing metol, mercuric bromide and sodium sulphite. The following experiment shows the remarkable persistence of the image. A plate was exposed for several weeks in perfect darkness close to, but not in actual contact with, a plate of common amalgamated battery zinc. It was then immersed in a weak fixing bath until all trace of emulsion was removed, washed and immersed in the above-mentioned developer. The development was carried in the light. A strong image was obtained. The plate was mounted as a lantern slide, and afterward put away for a couple of years with other slides. The image gradually disappeared, and finally only a few small spots were left. The plate was again immersed in the special developer, and in a few minutes the image appeared in good strength. It seems that the latent image may reside on gelatin as much as in the silver halide.

Finally, as an interesting instance of how difficult it is to fix definitely the time and place of scientific discovery, and to assign honors, therefore, an illustration is appended taken from the *Bulletin of the French Society of Photography* (3d ser., 1922, ix, 206). It shows twin pictures drawn by an artist so that, when viewed in the stereoscope, a good impression of solidity is produced. The fact that the impression of solidity is given by the joint action of both eyes was known to Euclid, three centuries before the beginning of the common era and also to Galen five centuries later, but this knowledge, as was the case with much other information, appears to have been practically lost during the dark age. Prominent workers in the early period of the revival of learning, *e. g.*, da Vinci and Porta, revived this knowledge, but it was left to Wheatstone in 1838 to devise a special instrument for producing effects of solidity from two pictures representing the image by each eye, respectively. The effect was produced by mirrors. The instrument was called a "stereoscope." Much later, Brewster devised one in which lenses are used, which became the regular form. The illustration taken from the French journal

shows a stereoscopic combination that is stated to have been drawn in the fourteenth century, by an artist named Jacopo Chimenti, and is now in the Wicar Museum at Lisle. The drawings are in different ink, one red, the other black. It does not appear that there is any record of an apparatus constructed for viewing the pictures, but the matter is of great interest in the history of stereoscopy.

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SCIENTIFIC AND TECHNICAL ABSTRACTS

SILICON IN ALUMINUM.—Silicon and iron are the two impurities met with in aluminum coming directly from the vats in the electrolysis of the oxide.

The percentage of these elements, depends upon several factors, the purity of the aluminite and cryolite, the electrodes, and the interior lining of the vats, but the variation of temperature during electrolysis also produces an effect.

The commercial value of aluminum in all countries is determined by the silicon and iron content. The traces of other elements (nitrogen, titanium, carbon, sulphur, phosphorous, etc.) are such as to be estimated with great difficulty. At the moment of casting a little oxygen is fixed in the state of oxides. Sodium, which has been blamed as a cause of alteration of aluminum is not met with—this element not being miscible with, nor forming any combination with aluminum; results published in regard to that element are based on error; the sodium found, issued from reagents and from vessels which had been used presumably for other operations.—(*Anal. de Chimie Analytique,* 15th Jan., 1923.) W. H. G.

SEPARATING OXYGEN FROM ATMOSPHERIC AIR.—A recent invention relates to improvements in the method of separating oxygen

from atmospheric air, which takes advantage of the power of hæmoglobin to absorb or combine with oxygen and to part with it again in the state of gas when the conditions of temperature or pressure or of both are varied.

The patentees point out that a difficulty in the way of a commercial application of the method resides in the ease with which solutions of hæmoglobin ferment or putrefy; and it has been proposed to avoid the difficulty by subjecting the solution to sterilizing agencies such as light, or by adding a substance capable of preventing fermentation. They have found that by observing certain conditions of temperature, putrefaction of the hæmoglobin can be prevented sufficiently to permit a practical process.

According to the present invention, the temperature of the solution or suspension of hæmoglobin is kept either very near 0° C. (or below this), or at a temperature just lower than that at which the hæmoglobin coagulates in the presence or absence of a protective colloid—in absence of the latter the temperature of coagulation is about 57° C. In order to avoid frothing while the oxygen is being withdrawn from the solution or suspension, the latter may be forced into a vessel where it is broken up into a fine spray at a considerably lower pressure. It is advantageous to operate at about 57° C., and to pump the air into the solution or suspension under pressure; the oxygen being subsequently withdrawn at lower pressure—for instance, at 0.25 atmosphere. A higher temperature affords a more rapid operation; but the coagulation of the hæmoglobin by heat presents some difficulty, which may be avoided or delayed by the use of a protective colloid.

The following examples illustrate the invention:

1. Fresh hæmoglobin, prepared in the usual manner, is dissolved in water to form a solution of 12 per cent. strength. This solution is caused to circulate through an absorption tower of any suitable kind kept at a temperature of about 0° C., in which it meets an ascending stream of air similarly cooled; then over a surface kept at a temperature of about 0° C. in a vessel connected with a suitable pump for withdrawing gases from it; and finally through a cooling device, from which it is returned to the absorption tower. The gases withdrawn by the pump may be expected to contain 75 per cent. of oxygen and to amount to 10 per cent. of the volume of air passed through the absorption tower.

2. A solution of hæmoglobin in water of approximately 12 per cent. strength is kept at a temperature of 57° C. in a suitable absorption tower through which air at the same temperature is forced under a pressure of 1.5 atmospheres; from the tower the solution passes through a suitable trap or valve into a chamber in which a pressure of about 0.25 atmosphere is maintained by a pump. From this chamber the solution may return to the pump for forcing it through the absorption tower; its temperature being kept as nearly as possible at 57° C. both in the vacuum chamber and in the return path. In this case the gases withdrawn by the pump may contain 75 per cent. of oxygen and may constitute 10 per cent. of the volume of the air passed through the pressure chamber.

MEDICAL AND PHARMACEUTICAL NOTES

SOLUTION FOR WASHING AND DRESSING WOUNDS.—Sodium bicarbonate, gm. ii; distilled water q. s., 1 litre; chloroform, 1 cm.; coloring as desired. The quantity of bicarbonate can be varied according as one desires the solution to be hypotonic, isotonic or hypertonic. The solution is employed as the Dakin solution; it is not caustic, the dressings made with it are inodorous.—(*Journal de Ph. et de Ch.*, 1922, No. 25, p. 98.) W. H. G.

PROFESSOR BATTANDIER MEMOIR.—Professor Emile Perrot contributes a splendidly appreciative article in *Bull. das Sci. Pharmacol.*, January, 1923, on the life and work of Professor Battandier, of the Algiers Faculty of Medicine and Pharmacy. Professor Battandier, left an orphan at an early age, won his way against great odds, and through many struggles, to a commanding position in the scientific world, having published more than 130 papers and ten books covering the results of his researches. A man modest in the extreme and of an exaggerated timidity, with a powerful intellect and an overmastering love of pure science, he devoted his life to his specialty—botany. The development of North African French colonies

is largely due to the studies of the flora of that region, carried on by this man. Professor Battandier was also an accomplished pharmacist, having passed through the Paris School of Pharmacy. Born, 1848; died 1922.—W. H. G.

SWEDEN OPIUM CONVENTION.—On the occasion of the Swedish participation in the International Opium Convention, the Medical Council decided that raw opium, morphine, cocaine and their salts would in the future only be permitted to be imported through the medical profession or under medical control, through an appointed place by government order. The "apothecary-directors" of the country, who are first in authority for importing poisons, shall in future be deprived of this right. In order to protect as far as possible the proper rights of the pharmaceutical profession, and to obtain the confidence of the government in the proper administration of this proposed centralization of imports, a number of Swedish pharmamists have issued a call in *Svensk Farm. Tidskr.*, 1922, No. 31, for the purpose of forming a co-operative union for the importation and wholesaling of remedies.

According to good information there is an immediate prospect that such a co-operation would receive the commission to effect the import of the above-named medicaments, with the understanding, however, that such a union embrace a majority of the "apothecary-directors."—(*Journal Suisse de Pharmacie*, 25th Jan., 1923.) W. H. G.

TREATMENT OF WOUNDS BY PLACING IN ASEPTIC CAGES WITHOUT DRESSINGS.—For some time past the author has discarded the use of dressings in a certain number of cases: burns, ulcers, gangrenes, etc. He encloses them in a rectangular cage formed of rather stiff wire; the walls, lateral and inferior, being made of white cloth, preventing contamination, but of a texture permitting the passage of air, thus avoiding the moisture from perspiration. On the upper face is formed a window closed with a sheet of transparent celluloid, through which the progress of the case may be viewed. A drawing-string may be arranged in the cloth at the ends to allow the entrance of the portion of member under treatment. In the interior

may be suspended a tuft of cotton impregnated with a balsamic disinfectant, thymol, eucalyptol, etc. The cages permit the use of heated air by the introduction of electric bulbs.—(*Reynès in Bull. Acad. Med.*, 21 March, 1922.) W. H. G.

ADULTERATED ERGOT.—G. Tanert reports in *Rep. d. Phar.* (1923, [3], v. 33, 69) the examination of some samples of ergot, which had been sold as coming from Spain. On superficial examination no special peculiarity was noted, but careful inspection showed that the mass was made up of two species of grains. The true ergot grains were grayish, and fissured, the others were blacker and easy to pick out. The latter kind constituted about 17 per cent. of the mass. The general forms of these were noticeably different from those of true ergot, and were of a higher specific gravity, so that when a portion of the sample was thrown into water, the true material floated and the adulteration sank. The fracture surface of the false grains was grayish-yellow while that of true ergot is pale with a rose line near the periphery. The taste was farinaceous. The after taste, sweet and acrid, that characterizes true ergot was not noticed. A number of other tests are given in the article. The investigation showed that the adulteration was masses of wheat-starch paste which had been passed through narrow openings, and after being broken into length of suitable sizes, the fragments were colored by dipping first into red ink and then into black.—H. L.

DESTRUCTION OF VITAMINE B.—The heating of certain flours or of milk in the presence of alkaline products—such as sodium bicarbonate—leads to the destruction of the vitamine B. The prolonged cooking of milk or even the temperature of 180° for two or three minutes acts the same. This explains why certain compound alimentary flours, though composed of nutritive elements, possess very low nutritive value.—(*Annal. des Falsif.*, 1922, No. 15, p. 288.) W. H. G.

MUMMY PERFUMES.—Modern chemists are particularly interested in the perfumes that were found recently in the tomb of King

Tutenkhamun, near Luxor, Egypt. For after a lapse of more than thirty centuries, these treasures apparently retain all of the delicate odor that made them so popular with the ancient ruler or his queen of the ancient dynasty.

These perfumes were discovered quite by accident. In the bottom of a box, covered with linen, were a number of little pots, containing a hard substance. Carried out into the hot sun, the contents of these pots melted, giving off a faint, aromatic odor. It is expected that an analysis of the liquid that remains will reveal to modern chemists some of the secrets of the ancient perfumers, who catered directly to royalty.

T. B. Bacillus Is of Animal Origin.—As the result of a chemical investigation of the tubercle bacillus extending over two years, this inveterate enemy of the human race was recently pronounced to be of animal origin by Dr. E. B. Brown and Prof. Treat B. Johnson, of Yale, in a paper before the organic section of the American Chemical Society. The verdict resulted especially from a study of turberculinic acid, the nucleic acid of the deadly bacillus.

There are two sorts of nucleic acids, each of characteristic composition, one derived from animal and the other from vegetable life. Brown and Johnson reported that they had positively identified the nucleic acid of the T. B. bacillus as of animal origin. The results are expected to be of far-reaching importance in the solution of the problem of how to control or eliminate the "white plague."

SOLID EXTRACTS

A German professor has discovered that birds are blind to the color blue, because they have yellow granules in the retina of their eyes which filter out the blue light rays. And so Maeterlinck's blue bird to its sister birdies is only a common canary.

Acetylene, the gas used in bicycle lamps and home gas plants, has been used by physicians in Freiburg, Germany, as an anesthetic with much the same results as have been secured with ethylene, the new anesthetic developed at the University of Chicago.

The acetylene, which is usually made by letting water come in contact with calcium carbide, is mixed with oxygen before administration to the patient who is to undergo an operation.

"Shaddock" is another name for the grape-fruit. The latter name originated from the fact that the fruit commonly occurs on the trees in large clusters, somewhat resembling grapes.

"Shaddock," the less common synonym for grape-fruit is in honor of a certain British sea captain, who is said to have introduced the fruit into the West Indies from Java early in the eigheenth century. It is interesting to note that in Java, which is the acknowledged home of the grape-fruit, there are two varieties. One is small and bitter, though edible, and grows in the lower coastal regions of the island. The other variety is much larger, intensely bitter, with a dark-yellow or red pulp; it grows at much higher altitudes and is known there as the non-edible variety.

Coke when highly heated in the electric furnace yields graphite, extensively applied as a lubricant. It is mixed with fine clay to make lead pencils, to the number of 2,000,000,000 yearly. It is further employed as electrodes for arc lights, as a stove polish, for coating non-conducting surfaces which are to be electroplated. A bug coated with graphite may be gold-plated.

Now that malaria parasites are being utilized to play ferret to locomotor ataxia and other end and by-products of syphilis, it will not be long before some biologic genius will tackle the potentialities of germ hybridization and find whether remedial combinations may be attained perhaps by crossing, let us say, a micrococcus with the colon bacillus. (Would this be a ; ?)

And speaking of hybridization, where is the pharmaceutical Burbank, who will open the road to experimentations along lines of crossing medicinal plants? Is there any more reason to doubt the possibility of effecting a marriage of hybridizable alkaloid-bearing plants, and so perhaps enhance their yield or change their therapeutic virtue—than to believe in some of the marvels of Burbank, such as the soft shell cocoanut and the seedless watermelon?

Increase of the speed of transatlantic cable transmission four- or five-fold is now prophesied as a result of the application to that work of a new alloy of nickel and iron.

The new metal to which the name "permalloy" has been given, is composed of about 80 per cent. pure nickel and 20 per cent. pure iron.

The organic chemist is on the job revolutionizing gland medicines. A recent discovery is the isolation, for practical administration, of the principle of the thyroid gland. Instead of the crude malodorous powdered gland, glittering crystals of the active constituent are now furnished to the doctor.

Pure crystalline thyroxin is this physiologically active constituent of the thyroid gland; a compound of definite and known chemical composition containing 65 per cent. of iodine, organically combined as an integral part of the molecule.

One grain of this substance is approximately equivalent to a grocer's pound of the moist gland.

Synthetic camphor, for medicinal use, built up from coal tar derivatives, will be produced by a new factory in Fügen, Austrian Tyrol. This is the first time that camphor, of the same composition as the natural product, has been made commercially. Artificial camphor formerly was restricted to industrial use. The process is the invention of an Austrian chemist, Anton Gawalowski.

Lead is one of the heavy weights and alcohol one of the bantam weights of the chemical world, yet Thomas Midgeley, chemist of the General Motors, has made them join hands amicably to vanquish the "knock" in automobile engines.

The new compound is an oil composed of six parts of ethyl, which is a group of carbon and hydrogen atoms always found in alcohol, combined with two parts of lead. By adding it to gasoline a lower grade of that fuel may be used without the engine knocking about it. Only a few drops are needed.

When carborundum is treated with chlorine, silicon tetra-chloride is formed, a heavy liquid, resembling pyrene, found in the well-known fire extinguisher. On contact with air, silicon tetra-chloride fumes strongly and when ammonia is applied, a dense white cloud results. This cloud was often used to protect our vessels against submarines during the late war.

Examination of the well-preserved mummies from the Luxor tombs, brings to light one very interesting fact regarding the condition of their teeth. Only 16.78 per cent. of the teeth showed any signs of caries at all, while it might be taken that of modern teeth 52 per cent. show signs of caries. The overwhelming percentage of the superiority of Egyptian teeth over modern teeth would have to be explained by the difference in feeding.

Egyptian bread was made from cereals which had been coarsely ground between stones, and it was subsequently badly cooked. The result was that the particles of flour were large, and in eating they could not be forced into the interstices, or any small cavities which might be there, so that the processes of decay could not be set up. It was concluded that the inferiority of modern teeth was due to the finer grinding of flour.

Before the days of scientific medical treatment the burning of incense was a principal part of the religious rite performed over every invalid; in later times aromatic oils were poured upon the head and rubbed over the skin of the sick; today, when one is confined to bed by illness, it is the custom of relatives and friends to provide sweet-smelling flowers for the sick room.

All of which suggests that pleasant odors are possibly therapeutic, although our knowledge of the subject is wholly empiric.

NEWS ITEMS AND PERSONAL NOTES

The growing business of Eli Lilly and Company in the East has made necessary the purchase of a substantial six-story, double-basement building, 50 by 114 feet, in downtown New York, at 79-81 Spring Street. The offices of the company are already installed at the new location. The building has been thoroughly overhauled and remodeled, and Eli Lilly and Company say that it will greatly facilitate the handling of both outgoing and incoming shipments. The New York branch was formerly located at 203 Fulton Street.

A. PH. A. RESEARCH GRANT.—The American Pharmaceutical Association has available a sum amounting to $400, which will be expended after October 1, 1923, for the encouragement of research.

Investigators desiring financial aid in their work will communicate before June 1 with H. V. Arny, Chairman, A. Ph. A. Research Committee, 115 West Sixty-eighth Street, New York, giving their past record and outlining the particular kind of work for which the grant is desired.

REMINGTON MEDAL AWARDED DR. RUSBY.—Dr. H. H. Rusby, Dean of the College of Pharmacy, Columbia University, has been awarded the 1923 Remington honor medal, by the New York Branch of the American Pharmaceutical Association, for his botanical researches and the discovery of a number of important drug plants in South America. The medal was presented to Dr. Rusby at a dinner given by the New York branch of the New York Pharmaceutical Association at the Pennsylvania Hotel in New York. Several members of the Philadelphia Branch were in attendance.

The Remington Honor Medal was established by the New York Branch of the American Pharmaceutical Association, four years ago, as a memorial to the late Prof. Joseph P. Remington.

CERTIFICATE OF RECOGNITION AWARDED TO A PHARMACY.—At the Industrial Exposition held in the Twenty-third Regiment Armory, Brooklyn, N. Y., April 7 to 14, the Chamber of Commerce awarded a number of certificates of recognition to industrial, commercial and professional institutions that have been in business over twenty-five years in the Borough of Brooklyn.

It is a pleasure to note that one of Brooklyn's oldest and well-known professional pharmacies obtained such a certificate, *i. e.*, the Verona Pharmacy, 1341 Fulton Street, corner Verona Place, established in 1874 and serving the community continuously during the past forty-nine years. The owner, Professor Otto Raubenheimer, well known in pharmacy throughout the world, is justly proud of the handsomely engraved certificate of recognition, a splendid tribute to professional pharmacy.

BOOK REVIEWS

THE RIDDLE OF THE RHINE. By Victor Lefebure. E. P. Dutton and Co., New York.

This book, which concerns itself with chemical strategy in peace and war, was written by a French chemical liaison officer during the war, and is distinguished by having its preface written by Marshal Foch and an introductory chapter by Field Marshal Sir Henry Wilson, Chief of the Imperial General Staff.

Taking up the subject of chemical warfare chronologically from the first cloud gas attack, which occurred on April 22, 1915, and following it through to the armistice with a wealth of illuminating and informative details, the author with convincing clearness proves the interdependence of the organic chemical industries and those engaged in the production of substances used in gas warfare. The significance of the German dye industry is made more apparent when we are informed that it is one of the integral factors in the great German *Interessen Gemeinschaft* (I. G.), a world power inorganic chemical enterprise, a soulless, grasping monopoly, which has distinguished itself for years by its ruthless methods of competition and which still casts its menacing shadow on the outer world.

The principles of the Versailles Treaty dealing with this phase of disarmament, are absolutely valueless because they are unsupported by adequate methods of control. There is no doubt whatever that the existence of the German dye factories was largely responsible for the first German use of gas on the front, and that preparations for such an attack had been clandestinely carried on for a long time previously. The allies were not only caught unawares in a military sense, but they possessed few industries capable of producing similar materials. As the author correctly says: "They lacked these industries because of a blameworthy disregard for the fundamental importance of science, and particularly chemical science, in industry."

Again he states: "From the point of view of results on the front the German dye factories, when considered as a war weapon, were as much in advance of allied improvised plants as a military, quick-firing gun is ahead of the old muzzle-loader." It is a blow to our pride to learn that "American preparations, although on a colossal scale, were not in time to influence the campaign seriously and directly."

The fiendish ingenuity with which the Germans had laid their plans long before the war, to discourage the use of their patented processes, is illustrated by the fact that many German patents were found to be absolutely unworkable, and in one case, the experimenter would be very likely to lose his life in attempting to carry out the process as recorded.

It will be little solace to the chemists of the country to repeat "I told you so" after the inhabitants of one of our great seaport cities have been destroyed by the use of deadly substances hurled from the air, and this might easily be accomplished within a few hours after hostilities had been declared, in the event of another war with Germany. The book is obviously of the propaganda type, but it is a kind of propaganda which is necessary. The statements made in the book are supported by quotations from or references to official reports and records. It is excellently indexed and will be of value as a work of reference in any library in which it finds a place.

"The Riddle of the Rhine" should be read by every intelligent American citizen. Every Congressman and Senator should be locked up in a room with a copy of the book and not liberated until he can discuss it intelligently. Any individual who can read this work

and not acknowledge the danger of permitting Germany to regain her world control of dyestuffs and organic chemicals is either lacking in mental competency or is an enemy to our country.

C. H. L.

GLUE AND GELATIN. By Jerome Alexander. Published by the Chemical Catalogue Co., Inc., 19 East Twenty-fourth Street, New York. Bound in cloth, 236 pages, price $3.00.

This is one of the series of very excellent monographs now being published under the auspices of the American Chemical Society, a fact which classifies this book on glue and gelatin as of importance.

The author, Jerome Alexander, is not only a specialist in the field dealt with in this monograph, but is the author of textbooks on colloid chemistry, and therefore particularly qualified to discuss the bearing of this important branch of science on the problems presented by glue and gelatin—colloidal material of great important industrial interest. The monograph opens with a discussion of gelatin with reference to its chemical and physical nature and properties, but deals also with the technology of gelatin and glue, its testing and grading, or standardizing—and with such industries as tanning, which involve the chemical treatment of collagen.

The author quotes the reports and conclusions also of other investigators, and provides a rich bibliography of the subject.

The book is a valuable contribution to the literature of glue and gelatin, as it co-ordinates and classifies the findings of modern workers in this field of research.

J. W. S.

FUNDAMENTALS OF BIO-CHEMISTRY. By T. R. Parsons. W. Heffer & Sons, Ltd., Cambridge. x + 281 pp., 12.5 x 22 cm., 1923.

"While the study of physiological chemistry has been adequately dealt with from the *practical* point of view, the *theoretical* treatment of the subject seems still to be confined to larger treatises containing a much greater wealth of detailed information than is appropriate in an elementary introduction suitable for readers new to

the subject. It appeared desirable, therefore, to attempt to describe in a continuous story the more important generally-accepted principles which have been derived from the study of the chemical changes occurring in the human body. The present volume represents the result of such an attempt."

This paragraph from the foreword amply describes the scope of Mr. Parsons' book and it seems to the reviewer that he has ably completed the task to which he set himself. The first chapter considers the nature of living matter and the constitution of the proteins. The six chapters which follow deal with the biochemistry of the proteins, then in order come discussions of the fats and the carbohydrates with an interesting chapter on the pathology of carbohydrate metabolism, the enzymes, vitamines, pigments, respiratory gases, and two chapters on the applications of physical chemistry in biochemistry.

The outstanding feature of this book is the manner in which the subject is presented. Mr. Parsons has a broad field to cover and is forced to discriminate carefully in the choice of subject matter in order to present details enough to illustrate the fundamental principles which he is expounding, but not to include non-essentials and not to bury the important data under a mass of inconsequentials. He has done this part of the work well. In addition he writes with an ease and grace which adorns the page and injects vibrant life into the text. There is no appearance of haste, although the book covers a wide expanse and covers it thoroughly. It seems that any one who has a small acquaintance with general chemistry can read this book with much profit.

JAMES F. COUCH.

THE PHARMACEUTICAL SYLLABUS, THIRD EDITION, OUTLINING COURSES OF INSTRUCTION FOR THE DEGREES OF GRADUATE IN PHARMACY (PH. G.) AND PHARMACEUTICAL CHEMIST (PH.C.).

This valuable compendium of educational information is the joint production of the pharmaceutical *triple entente,* consisting of a joint committee representing the American Pharmaceutical Association, the American Conference of Pharmaceutical Faculties and the National Association of Boards of Pharmacy.

The purpose of the work is to outline minimum courses for the degrees named which shall be suggestive to colleges in planning and developing their curricula and serve as a guide to board members in the preparation of examination questions.

The two previous editions were rather severely criticized by some pharmaceutical educators as impracticable from the standpoint of actual accomplishment of the work outlined in the time given and also for a lack of proper balance in the time allotted to the different subjects of study.

The present edition is a great improvement over both of the foregoing issues in these and other important respects and is a credit to the industry and ability of the committee in charge of the work.

The advantage of such a work is so apparent as to need no emphasis. It should serve as a guide and inspiration to pharmaceutical educators and board members and will be of interest to all who are sincerely concerned with the professional development of pharmacy.

C. H. L.